METHODOLOGY FOR EVALUATING IMPACTS OF SPILLS REMEDIATION AND OTHER REMEDIAL OPTIONS UPON DON RIVER WATER QUALITY – SUPPORTING DOCUMENT #3

STRATEGY FOR IMPROVEMENT OF DON RIVER WATER QUALITY

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METHODOLOGY FOR EVALUATING IMPACTS OF SPILLS REMEDIATION AND OTHER REMEDIAL OPTIONS UPON DON RIVER WATER QUALITY - SUPPORTING DOCUMENT # 3: STRATEGY FOR IMPROVEMENT OF DON RIVER WATER QUALITY

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Report prepared for:
Steering Committee
Toronto Area Watershed Management Study

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EXECUTIVE SUMMARY

This document evaluates the impacts of spills on the Don River. It also provides background data for the effectiveness analysis developed in Supporting Document 1 and costing information developed in the Summary Report.

Impacts of Spills

The significant findings with respect to spills are as follows:

1. Many of the spills are composed of petroleum or petroleum products. This is caused by petroleum being a liquid which can move and it being one of the main liquids used in an urban environment.

2. Industrial land uses are a significant source of spills. Many of the origins of the spills are fixed sources in Metropolitan Toronto. Many of the origins in both Metro and the Region are associated with petroleum products and other mobile sources.

3. Old industrial areas in the Lower Don are associated with unreported, spill events which reach the river as a discoloured "spike" in the storm sewers. There is a perception that many "unknown origin" spills are observed in new industrial areas, especially from new industrial plazas along small tributaries. The "spill" occurs by accidental or intentional disposal of solid or liquid waste along the back of the industrial plaza or via transport in storm sewers from floor drains etc.

4. The actual magnitude of spillage (i.e., mass) reaching the river system is unknown. Priorities to increase our understanding of the impacts of spills are suggested.

5. A pathways analysis of a spills event composed mainly of petroleum products was used to establish the possible aquatic toxicity associated with the spill. Spills of the size typically observed in the Don River watershed may be as toxic to aquatic biota as CSO overflows or stormwater runoff. Due to the lack of quantitative information about the magnitude of spills which reach the Don River, this study hypothesized that the appropriate method for incorporating spills evaluation into aquatic toxicity and fish habitat studies is the frequency of occurrence of spills, rather than the magnitude of a spill.

This hypothesis was used in Supporting Document 2 to evaluate the impact of spills upon Fish Habitat. Future efforts in this regard should attempt to define the amount of contaminants reaching the river, and the kinetics of uptake of the contaminant into fish to assist in improving the estimation of toxicity.

6. Many spills are detected by present reporting systems. However, some spills will not be detected, unless an end of pipe or end of ditch audit is made. Such an audit is carried out periodically by North York during the summer months. A spills audit in association with daily sampling in one of the TAWMS (Humber) catchments showed a surprising number of spill-like events (i.e., the appearance of "discoloured spikes").

   A detective system similar to that used by East York upon key catchments is one method which can be used to confirm the frequency, the probable magnitude and the constituents of spills reaching the river system.

7. The success of spill control programs is reasonably well demonstrated qualitatively.

8. There is a mixed opinion among the various municipalities about what would constitute an optimum spills management program. It can be broken down into management and structural elements.

   a) Structural Elements

   Structural elements would be used to trap spills before they reach the Don River Watershed, particularly along highly prone areas of repeat offense. They would include:

   i) spill control ponds, on ditches along major transportation corridors (highways like 401, rail lines).
   ii) API (American Petroleum Institute), oil-water, type separators and skimmers or similar devices on storm water systems draining highly prone industrial areas (e.g. new industrial plazas).
   iii) installation of appropriate structures in old industrial areas as they redevelop.
   iv) spill control ponds upstream of wet ponds installed for other water quality and aesthetic purposes.

b) Management Systems

Management systems would include the following:

i) a common data base on all reported spills.

ii) development of procedures for all fire department crews to contain spill as much as possible. Note: all fire departments do this to a varying degree.

iii) advising all municipalities on model spills control procedures by MOE (the document describing a "model program" is yet to be developed).

iv) investigation of and maintenance of ancilliary equipment on standby at one or two designated centres to be used in support of Fire Department or Works Department response. Investigation of whether this equipment should be integrated with Fire Departments, Works Departments, or maintained at a separate centre.

v) investigation of the information reported to agencies handling other emergencies (e.g., police, fire department, 911, ambulance) to see if common links can be implemented or whether better information upon initial reporting will assist in the control of spills.

vi) active follow-up by a designated agency with information relayed back to the Region or local municipality.

vii) application of industrial data bases available at fire departments to the spills response system; development of these data bases where they do not presently exist.

viii) uniform training of designated response team leaders and others called in on an "as needed" basis.

Effectiveness, Costs and Environmental Amenities of Water Quality Control Options

Background information concerning the control options for water management of stormwater runoff is provided as follows:

o Effectiveness (high, medium, low) for all possible management options (Chapter 4).

o An overview of environmental benefits and amenities and maintenance and safety problems of wet ponds (Chapter 5).

- Background costing data (Chapter 6).
- Implementation aspects used to assist in developing the Strategy (Chapter 7).

FOREWARD

Study Background

In 1981, the Ontario Ministry of the Environment (MOE) began a study of water quality in the Don River, Humber River and Mimico Creek to provide baseline data to guide future studies. The following year, the Toronto Area Watershed Management Strategy Study (TAWMS) was initiated as a comprehensive and co-operative multi-agency undertaking towards the attainment of water quality improvements.

The TAWMS study objectives are:

- To better define water quality conditions with the study area;
- To analyse the cause and effect relationships for problem constituents and areas; and
- To develop cost-effective measures for controlling pollutant loadings to the study area's receiving waters based on watershed needs and users.

Although wholly funded by MOE, TAWMS receives extensive co-operation and support from the Metropolitan Toronto and Region Conservation Authority (MTRCA), Metropolitan Toronto and area municipalities.

The TAWMS study is managed by a Steering Committee which includes representatives of the following:

Ontario Ministry of the Environment
Ontario Ministry of Natural Resources
Metropolitan Toronto & Region Conservation Authority
Environment Canada
Metropolitan Toronto
Borough of East York
City of Etobicoke
City of North York
City of Scarborough
City of Toronto
City of York
Regional Municipality of York
Regional Municipality of Peel
Town of Richmond Hill
Town of Vaughan
Town of Markham

A detailed study of the Humber River was carried out during the period 1982 to 1985. In 1986, the TAWMS Steering Committee released a Management Plan for the Humber River. Recommendations which were outlined in this plan are presently being implemented.

The TAWMS Don River Water Quality Improvement Study was commissioned as an external contract to Paul Theil Associates Limited and Beak Consultants Limited in the spring of 1988. The study's mandate was to summarize water quality problems, relate these problems to sources and to provide a range of improvement actions leading to various levels of control for water quality improvements. Options investigated for water quality improvement range from no further degradation to the full restoration of water quality in the Don River. The findings were presented as alternatives or staged management strategies which will lead to several milestones or levels of water quality improvement.

The improvement strategy incorporates findings from previous investigations of low flow and storm event conditions, snow melt, the status of biological communities and general water quality conditions within the Don River.

Public consultation on a number of strategies for water quality improvement for the Don River, combined with inputs from a range of municipalities and agencies will provide valuable direction for drafting the final Don River Management Plan. Improvement strategies outlined in this report for the Don River and other rivers which drain into the waterfront will be considered in context of the Metro Toronto Remedial Action Plan (RAP), a provincial-federal initiative for protecting water quality in Toronto's waterfront.

Implementation considerations and costs are important components in this option selection/consultant process, since they identify in simple terms what it will take to achieve a range of improvements and benefits or designated uses of the Don River. This consultation process will also recognize the will of municipalities, government agencies, developers and the public to support selected undertakings to protect and enhance water quality in the Don River.

The time span in which water quality improvements are to be derived and the ultimate costs will depend upon the levels of protection and the phasing of controls selected on the basis of public feedback and agency and municipality endorsement. It is recognized that effective improvement actions in the Don River watershed will also require creative solutions and new approaches by the municipalities and government agencies.

In addition to the remedial measures proposed in the strategy, a number of immediate actions are presently underway to address water quality problems by means of regular municipal and conservation authority works and maintenance programs, or through Ministry of the Environment programs such as the Waterfront Water Quality Improvement Program which funds physical work on the watercourses, waterfront or sewers yielding immediate benefits.

This document is Supporting Document 3 for the study. The complete set of study reports are as follows.

1. STRATEGY FOR IMPROVEMENT OF DON RIVER WATER QUALITY: SUMMARY REPORT
2. SUPPORTING DOCUMENT NO. 1: QUANTITATIVE METHODOLOGY FOR ESTIMATING RESPONSE OF DON RIVER TO WATER QUALITY CONTROL
3. SUPPORTING DOCUMENT NO. 2: FRAMEWORK FOR EVALUATING RESPONSE OF AQUATIC TOXICITY AND FISH HABITAT TO WATER QUALITY CONTROL IN THE DON RIVER
4. SUPPORTING DOCUMENT NO. 3 METHODOLOGY FOR EVALUATING IMPACTS OF SPILL REMEDIATION AND OTHER REMEDIAL OPTIONS UPON DON RIVER WATER QUALITY
5. SUPPORTING DOCUMENT NO. 4: PROBLEM DEFINITION: PRESENT STATE OF WATER QUALITY IN THE DON RIVER
6. SUPPORTING DOCUMENT NO. 5: ANALYSIS OF WATER QUALITY DATA FOR THE DON RIVER

Availability of Reports

Copies of the Supporting Documents and the Summary Report for the Strategy for Improvement of Don River Water Quality are available through the:

Public Information Centre
Water Resources Branch
135 St. Clair Avenue W.
Suite 100
Toronto, Ontario
M4V 1P5
(416) 323-4321

DISCLAIMER

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THIS REPORT HAS BEEN REVIEWED BY THE STEERING COMMITTEE AND APPROVED FOR PUBLICATION. APPROVAL DOES NOT NECESSARILY SIGNIFY THAT THE CONTENTS REFLECT THE POSITION AND/OR POLICIES OF INDIVIDUAL AGENCIES.

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APPENDIX 2: Summary of Response to Spills Questionnaire Developed and Sent Out in this Study

APPENDIX 3: Critique of Spills Response Program Developed from February 1989 RAP Survey

1.0 INTRODUCTION

The costs and effectiveness of control options for improving water quality in riverine and lacustrine systems has received much attention in the literature. Most attention has been given to passive and non-passive measures for regular sources of contaminant discharge (stormwater discharges; combined sewer overflows, CSOs; sewage treatment plant discharges). Relatively less attention has been given to the impacts of spills and to the effectiveness of spills remediation upon receiving water quality because the potential influence of spills has only recently been recognized. Accordingly, one major thrust of the "Strategy for Improvement of Don River Water Quality" study was to amplify the conceptual framework and database for assessing the potential impact of spills control upon riverine water quality.

This supporting document presents the following:

- a framework for evaluating the impact of spills upon river water quality;
- the potential effectiveness of spills remediation;
- a list of different control options for improving riverine water quality (source control; treatment of waters released to the river system);
- data describing the effectiveness of different control options for reducing contaminant loadings to the Don River; and
- data describing the costs of the different water quality control options.

1.1 Spills Remediation

Spills are the leakage of liquid constituents from potentially definable sources in a pulse manner along hydraulic or hydrological pathways which may enter receiving waters.

In this study, some effort was expended to obtain a definition of spills which was meaningful to most participants.

For example, the issues of:

- spills; versus
- illegal dumping; versus
- leachate from old dumps and landfills; versus
- non-point source runoff

continually arose as new participants were brought into the study deliberations. In particular, the intent behind the cause of a spill was a vexing issue: accidental (e.g., due to malfunctioning equipment) versus intentional. The physical source of the spill was also an issue: transportation (mobile) versus fixed (on-site).

Accordingly, a spill is defined, in this study, as the accidental or intentional release of a pollutant in a liquid form in a pulse manner to aquatic conveyance systems (ditches, storm sewer systems, groundwater systems) which lead to surface receiving waters (ponds, reservoirs, rivers, lakes).

Because spills are associated with fast response times, aquatic pathways which rapidly impact surface waters (ditches and storm sewers) are the main routes of concern to this study. Different issues associated with spills, including

- reported, unreported
- accidental, intentional, and
- mobile (transportation) source, fixed (on-site) source

were used as categories for classifying information obtained concerning spills in the different political units contained wholly or in part within the Don River watershed.

The objective of this work related to spills was the following:

(i) Define the nature and scope of the problem from available data;

(ii) Develop a qualitatitve or quantitative approach for assesing their impact upon aquatic toxicity and fisheries habitat; and

(iii) Evaluate possible control options and management techniques, their effectiveness and their cost.

The framework required to address the second objective provides the conceptual approach to this study. The evaluation of the effect of spills upon aquatic toxicity and fisheries habitat are covered in detail in the Supporting Document No. 2.

A general framework for objective (ii) is first presented here (Section 2). Then the probable scope of the problem and management approaches are described (Section 3).

1.2 Effectiveness and Costs of Control Options

Management of water quality involves structural methods, technical approaches and management approaches. Information used to evaluate effectiveness and costs of water quality control in the Summary Report are presented in this document. Background information of the effectiveness of the various structural and management approaches for water quality control are first documented (Section 4). Then various issues associated with wet ponds and design examples are presented (Section 5). Finally some costing data used for the summary report are developed in Section 6, and some implementation aspects involved in developing the recommended strategy are presented in Section 7.

2.0 FRAMEWORK FOR EVALUATING IMPACT OF SPILLS IN THE ENVIRONMENT

2.1 Conceptual Framework

A set of pathways for evaluating the risk to humans of releases of contaminants to the ecosystem is given in Figure 2.1. This diagram shows the environmental pathways by which a liquid spill from any source can impact humans. In constructing the pathways, it is assumed that the spill receives some degree of treatment (such as an STP or spill control pond) or containment (such as sorbents at the site).

The pathway diagram describes all pathways which can impact humans, including:

- atmospheric,
- surface water, and
- groundwater.

The main pathways of concern to this study are through surface waters. Of the various routes from surface water illustrated in Figure 2.1, the aquatic animals, sediment and ingestion/immersion would have the most direct effect. Not considered in such a diagram is the visual impact (aesthetics) which is difficult to assess.

A smaller scale set of pathways which relate the source of a spill to biological impacts in the Don River is given in Figure 2.2. A scenario of the possible concentrations at three points along these pathways is given in Figure 2.3. These two latter figures provide the conceptual framework for information required to develop a quantitative understanding between spills, biological effects, and their control.

The spill may occur anywhere in an urban or rural area. It generally occurs on a land surface but occasionally directly onto a water surface. Information required for conducting a pathways assessment of impacts includes the location of the spill, its magnitude, its frequency of occurrence and the contaminants it contains.

Before entry to hydraulic conduits which transport the spilled material to the river, there are opportunities for partial or complete control of the spill, depending upon the time at which it is reported. Control efforts in the past mainly concentrated upon flushing.

FIGURE 2.1: PATHWAYS FROM CONTAMINANT SOURCES TO FISH AND HUMANS

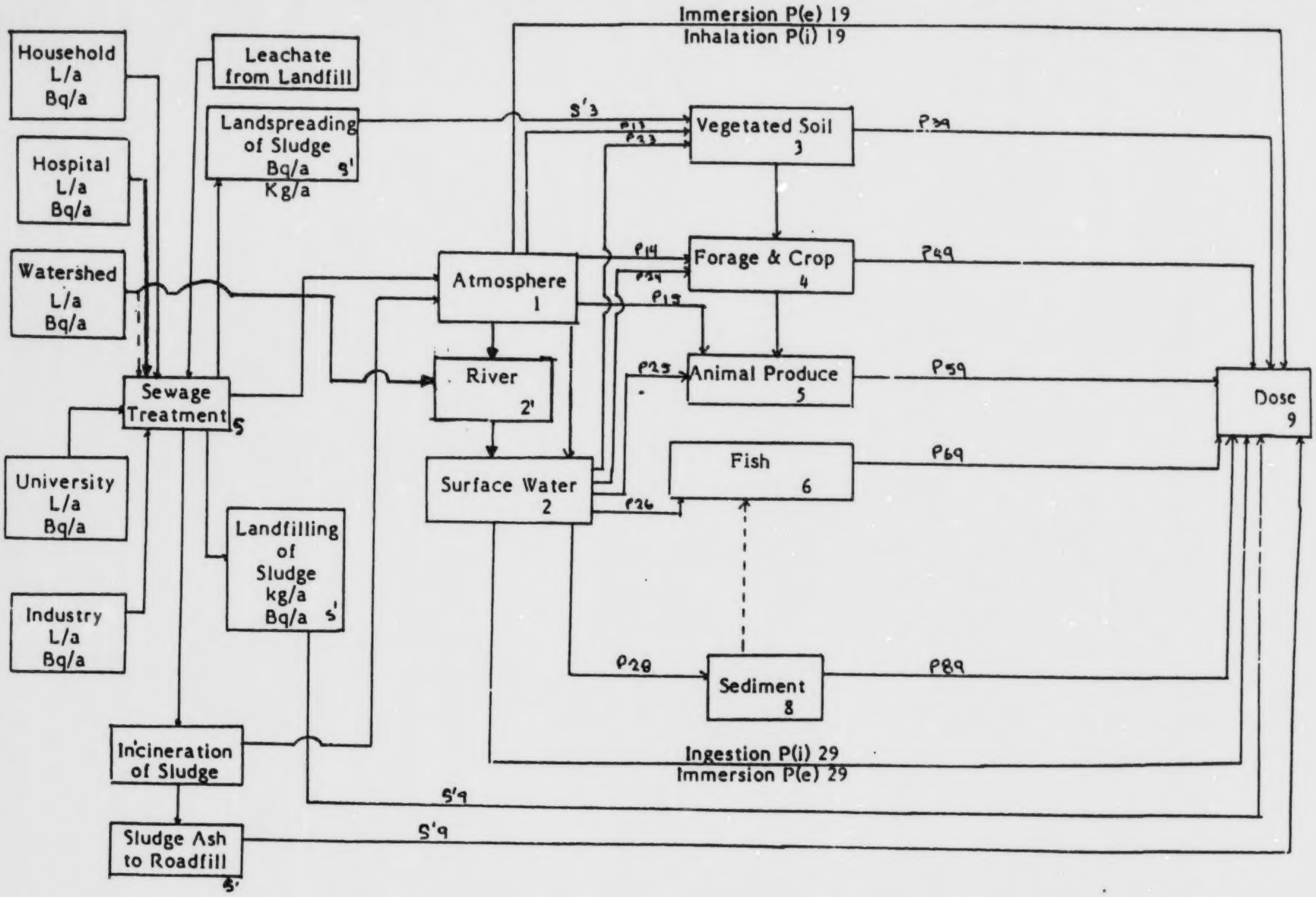

Immersion P(e) 19
Inhalation P(i) 19
Household
L/a
Bq/a
Hospital
L/a
Bq/a
Watershed
L/a
Bq/a
University
L/a
Bq/a
Industry
L/a
Bq/a
Sewage Treatment
S
Leachate from Landfill
Landspreading of Sludge
Bq/a
Kg/a
S'
Landfilling of Sludge
kg/a
Bq/a
S'
Incineration of Sludge
Sludge Ash to Roadfill
S'
Atmosphere
1
River
2'
Surface Water
2
S'3
P13
P23
P14
P24
P15
P25
P26
P28
Vegetated Soil
3
Forage & Crop
4
Animal Produce
5
Fish
6
Sediment
8
P39
P49
P59
P69
P89
Dose
9
Ingestion P(i) 29
Immersion P(e) 29
S'9
S'9

FIGURE 2.2: SPECIFIC PATHWAYS RELATING SPILLS TO BIOLOGICAL EFFECTS IN DON RIVER

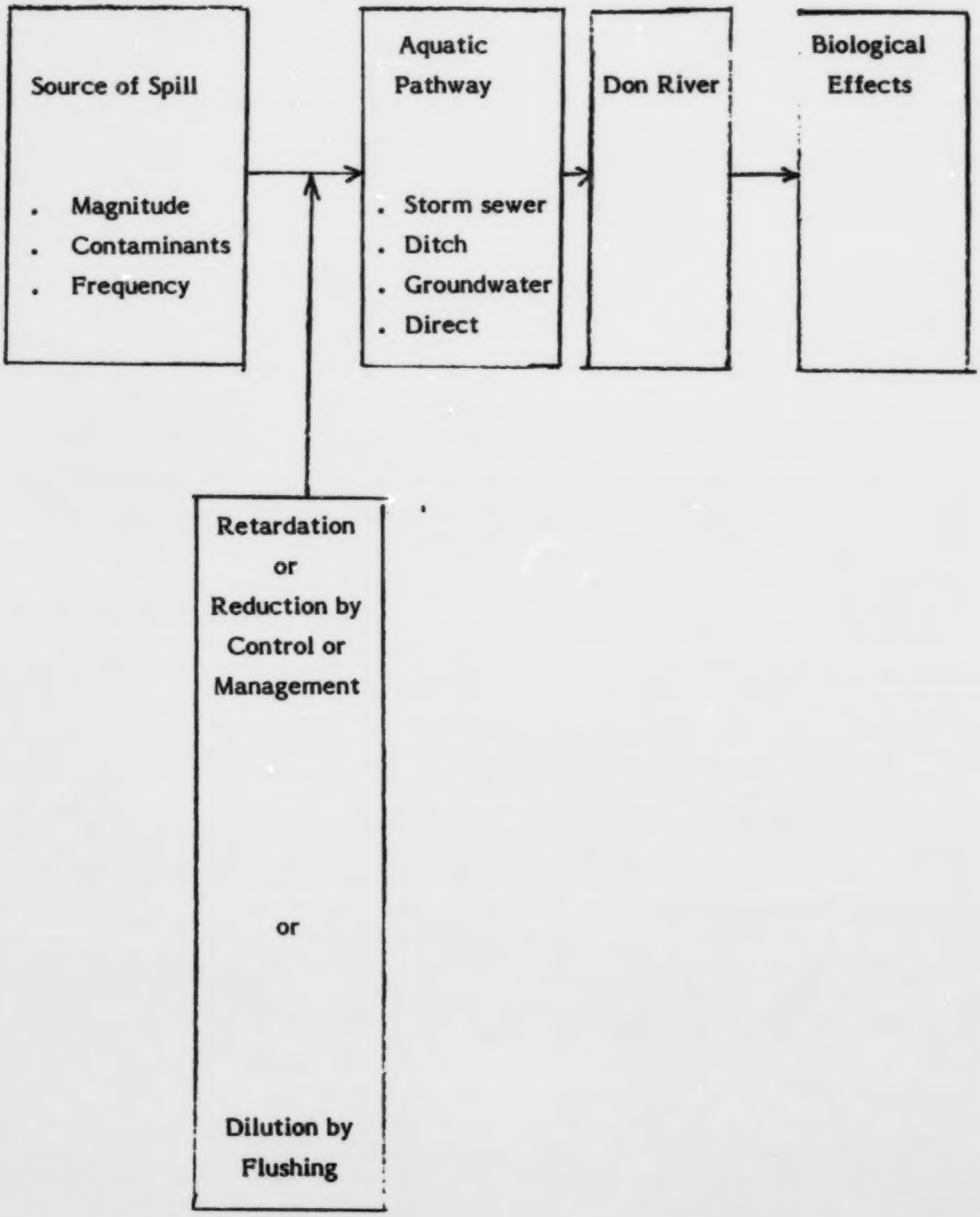

Source of Spill
. Magnitude
. Contaminants
. Frequency
Aquatic Pathway
. Storm sewer
. Ditch
. Groundwater
. Direct
Don River
Biological Effects
Retardation or Reduction by Control or Management
or
Dilution by Flushing

FIGURE 2.3: CONCENTRATION PROFILES ALONG AQUATIC PATHWAYS
(a) if spill occurs in continuous fashion for period of time (Step Input) or
(b) if spill occurs as a very short pulse (Inpulse Input)

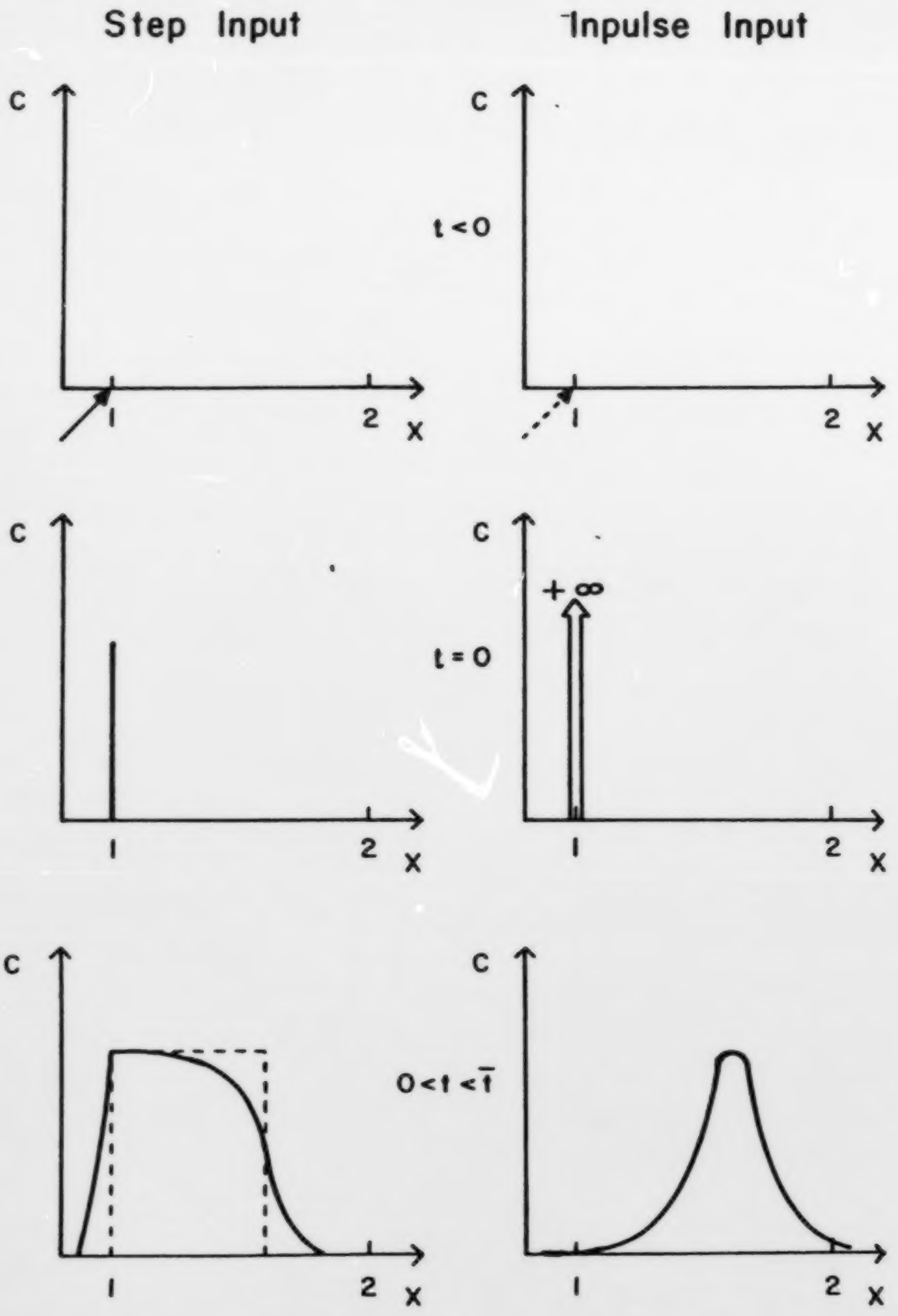
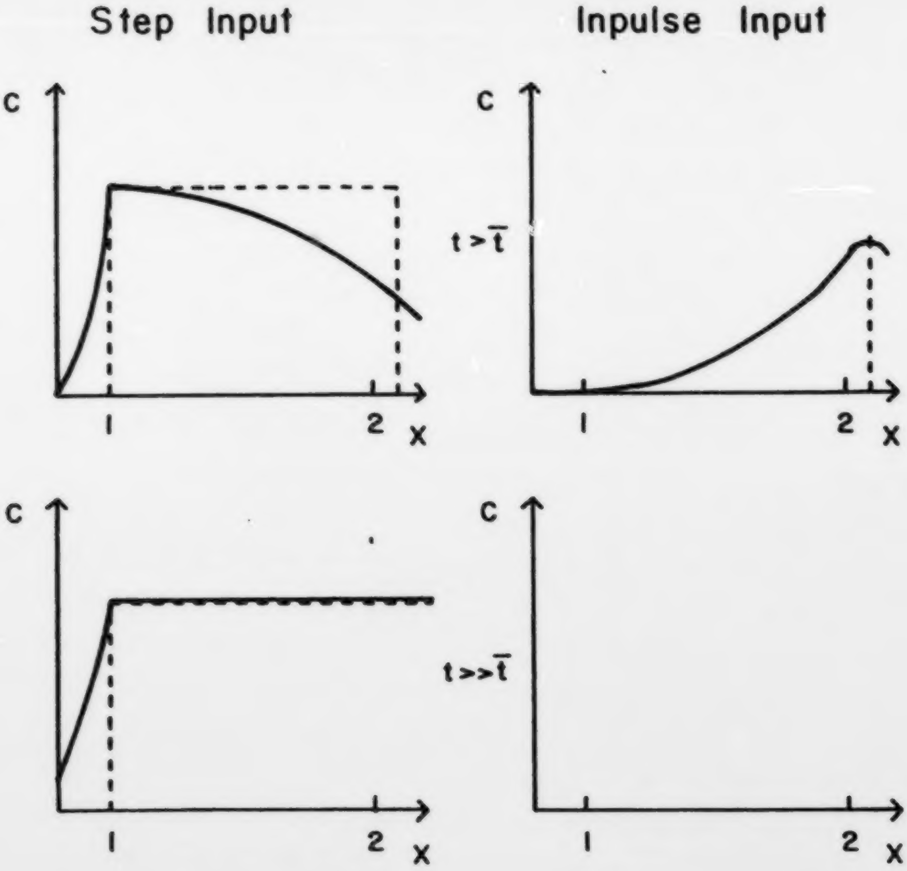


FIGURE 2.3:
(Continued)



Step Input

Inpulse Input

Recent control efforts have, in part, changed this philosophy to one of containment wherever possible.

Once in the river, little opportunity exists for control, except in the case of a major spill where active interception may be practised. In the river, the spill then impacts aquatic biota, particularly fish who spend their whole life cycle in the river water. They have opportunities to survive the spill only if backwater areas exist into which they swim, or if the concentrations of the contaminants are low enough or the spill duration is short enough to permit survival.

The aquatic toxicity can be expressed as the concentration of a contaminant which will cause acute (death) or chronic effects in fish when exposed for a required length of time. Laboratory assessment of acute effects to fish are normally based upon exposure for 4 days while chronic effects are based upon a longer period of time. Acute effects will occur at even higher concentrations for shorter durations of exposure than 4 days.

Hence, to evaluate the effect of spills, the concentration of exposure and the length of duration are required information. The concentration-time profile at different points along the pathway is given in Figure 2.3. The initial spill occurs in a near pulse manner (Figure 2.3) of high peak concentration and short duration. Some spills may differ, by being longer in magnitude due to a sustained leak. After entry into a ditch or storm sewer, the peak concentration may be more dilute due to larger water flow rates and extended in time due to retardation (Figure 2.3). Further retardation and higher flow rates in larger tributaries result in a lower concentration, and a long tailing tail (Figure 2.3).

2.2 Quantitative Framework

The concentration in the river may have the following algrabraic form based upon certain idealizations.

$$C = \frac{W'}{ZA\,(3.14\,Dt)^{0.5}} \exp\left(-(x-vt)^2/4\,Dt - kt\right)$$

Here: W' = mass of contaminant reaching the river (moles)
A = cross-section of area of river (m^2)
D = dispersion coefficient (m^2/day)
x = distance from place of discharge (m)
v = river velocity based upon flow rate divided by cross-sectional area
k = average loss coefficient (d^{-1})

The average loss coefficient incorporates the effects of loss by sorption, chemical decay and volatilization.

The concentration in the initial aquatic pathway may have the same algebraic form but in this case W' is replaced by W, the mass leaving the scene of the leak. Also, the cross-sectional area, velocity and the dispersion coefficient are defined by the characteristics of the connecting pathway.

The concentration in the initial pulse may have either one of two forms:

C = 0 for t less than 0
= 'del' for t greater than 0

or

C = 0 for t less than 0 and t greater than t_c
= C_o for $t = 0$, less than t less than t_c.

Here, 'del' is the function shown in Figure 2a which describes the pulse shape of the release. The second function describes spillage if it occurs at a constant rate for a time period t_c.

In either case, the duration of the spill is sufficiently short, relative to the duration in the receiving water, that it is idealized as a pulse for the receiving water equations given above.

2.3 Information Required to Evaluate Impact of Spills Upon Aquatic Toxicity

This framework and the algebra indicate that the following information is required to evaluate the effects of spills quantitatively.

(i) Magnitude of the spill, particularly the mass of potentially toxic contaminants in the spill.

(ii) Water flow rate in the connecting drainage system and the Don River. The flow rate in the connecting system includes existing flows and any augmentation by flushing at the site of the spill.

(iii) Dispersion and geometry of the connecting and receiving water systems.

(iv) Retardation or holdup effects due to control efforts or material constrictions in the receiving water.

In addition, information on the density and solubility of the material spilled is required. Spills composed of petroleum or other similar products spilled are relatively insoluble in water. Rather, a small portion dissolves and the remainder either floats on the surface or forms a mechanical mixture. The portion which dissolves or forms a mixture is useful information in assessing toxicity, as fish and other aquatic organisms may not be exposed to the maximum concentration of floating material on the surface of the water.

2.4 Incorporation of Spills Effect Into a Pathways Methodology

The following information would be required to incorporate these considerations into a pathway approach for evaluating toxic impacts upon biota:

- the frequency of exposure of the biota to different levels of concentration;
- the duration of exposure to different concentration levels;
- a mathematical relationship such as the following:

$$TU = \sum_{i} \sum_{j} C_{i,j}\ \mathrm{delt}_j/T_i)/C_{TH}$$

to describe the frequency/duration/exposure level. Here, the inner sum describes the duration of exposure to different concentration levels of any spill of length T_i while the outer sum describes exposure to all spills. The overall expression formulates the toxicity units of spills (TU), based upon a threshold efforts level, C_{TH} for a given chemical. The threshold approach is used for evaluating the toxicity of all chemicals in the Don River (see Supporting Document No. 2). In it, the threshold chemical concentration, at which acute or chronic toxicity effects are observed, is used as the method for normalizing different threshold concentrations of each element.

3.0 ASSESSMENT OF IMPACT OF SPILLS ON THE RIVER SYSTEM

3.1 Types and Quantity of Spills

3.1.1 Methods

A comprehensive assessment of the types, quantities, frequencies, and origins of spills in the Don River watershed was undertaken. A series of meetings involving various municipalities in the watershed, MTRCA and the Central Region and Water Resources Branch of the OMOE were initiated. They included: Bill Snodgrass, John Minor, Vic Lim, Merv Perkins, Alex Marich, Bela Nyitrai, Gord MacMillan, Doug Andrews, Wes Lammers, Zdenek Novak, Jane Atkinson, Jerry Klaus, Kim Choo-Ying, and John Sibbald.

A survey form was developed as a result of these meetings and mailed to the various participants for more information, prior to the study of Anderson (1989). All participants were telephoned to ensure return of the survey; this resulted in a full set of replies. Our survey attempted to establish the following types of information:

- number of spills,
- size of spills,
- type of reporting (reporting by originator; reporting by someone other than originator; unknown origins - detected subsequent to the fact),
- accidental or intentional,
- mobility of sources (mobile, fixed),
- examples,
- types of contaminants in spill,
- origins of spills according to land use,
- main areas in Don River impacted by spill;
- perception of most damaging type of spill,
- response system,
- relative weight of environmental protection to other concerns,
- resources available for clean-up,
- management systems required to improve spills response,
- new control options required, and
- costs of programs.

The questionnaire and the detailed response to each question is given in Appendices 1 and 2, respectively.

A second study was also conducted (R.V. Anderson, 1989) at approximately the same time as this study in support of developing a Remedial Action Plan (RAP) for the Toronto Waterfront. The objective of this second study was to document existing remedial programs affecting water quality of the Waterfront. In addition to evaluating the spills response of municipalities in the Regions of Peel, Metropolitan Toronto, York and Durham, the RAP study examined the following:

- cross connections,
- infrastructure programs,
- bylaws - pet control
  - plumbing inspection
  - sewer use
- catchbasin cleaning,
- hazardous waste, and
- aesthetic cleanup.

The RAP study concentrated upon evaluating the existing programs, the size of programs required if all municipalities had a common base of remedial programs and their costs. Our study concentrated upon evaluating the size of spills, their potential impact upon receiving waters and the effectiveness of control.

A critique of the results of the RAP study related to spills and the relative costs of spills management compared to the costs of other remedial programs is given in Appendix 3.

3.1.2 Results of Study Survey

Three different levels of government respond to spills reported by the originator or not reported by the originator. They are:

- the local government (e.g., Vaughan, Richmond Hill, Markham);
- regional government (Region of York, Region of Metropolitan Toronto); and
- Ontario Ministry of Environment.

A summary derived from Appendix 2 of the number of spills in 1987 estimated by the different level of government provides a useful data set for understanding the dilemna in evaluating results of the survey. This summary is now presented.

Metro Toronto

	Reported	Unreported	Unknown
Metro (Don R.)	10	2	31
Toronto	5	1	50 (est)
East York	few	NA	NA
North York	-	-	-
Scarborough	5 (est)	113 (est)	32 (est)
Total (Local)	10	114	82

Region of York

	Reported	Unreported	Unknown
Region	20	62	100 (est)
Vaughan	5 (est)	20 (est)	?
Richmond Hill	NA	NA	NA
Markham	NA	NA	NA

OME - SAC

	Reported		Reported
Toronto	18	Vaughan	7
East York	1	Richmond Hill	1
North York	12	Markham	7
Scarborough	18	Total	15
Total	51		

Reported spills are spills reported by the originator; unreported spills are defined as spills identified by someone other than the originator. Unknown spills are observations made on receiving waters or elsewhere that indicate a spill occurred sometime previously but it was not directly observed. Amplication of these deficiencies are given in Appendix 1.

There is a substantial range in the potential number of spills dependent upon how 'hard' the data are and upon the political boundaries involved. 'Hard' data are defined as being derived from a database while 'soft' data are based upon estimates by professionals at the municipality. The SAC data are 'hard' data. The Metro data (given above) are 'hard' data (see Table 3.1) but are only for the Don River watershed. The Region of York data are 'hard' data. The City of Toronto data are 'hard' data for reported and unreported spills.

The political boundaries used are generally the same. All estimates are for the whole municipality rather than for the portion of the watershed in the Don River watershed, except for the estimate made by Metro Toronto which was made specific to the Don River watershed by hand picking out locations within the Don River. The extra work involved in this activity by the Metro Toronto participant (V. Lim) is gratefully acknowledged.

The major differences between the data sources are caused by three factors: the presence of estimates in the data base, the fact that several of spills are reported to only one level of government, rather than to all three levels, and the differences in boundaries used for making the estimates.

Another significant difference among the municipalities is their estimate of the source of spills. Their estimates are as follows:

	Metro Toronto			Region of York	
	Fixed	Mobile		Fixed	Mobile
Metro	83%	17%	Region	10%	90%
Toronto	80%	20%	Vaughan	80%	20%
East York	NA	NA	Richmond Hill	NA	NA
North York	-	-	Markham	NA	NA
Scarborough	15%	85%			

There is either a significant difference in perception or actual variation across the region concerning origins. For example, Scarborough estimates 15% of spills reported to them are from fixed installations while the City of Toronto and Metro estimate that fixed installations comprise 80% or more of the spills reported to them. Similarly, the Region of York estimates that 10% of the spills reported to them are from fixed sources while the Township of Vaughan data would suggest that 80% of these sources are fixed (assuming that spills in transportation corridors represent their mobile data base).

More work is required to analyse the available data base and to develop a common basis for estimating the frequency and magnitude of spills preparatory to assessing the impacts. This would require an analysis of each spill reported, unreported, or unknown to each level of government to separate out those spills that are common to all government levels from those that are not common. Prioritization of spills along major and minor transportation routes may be most cost-effective for those municipalities where petroleum spills related to transportation are the major origin. It would be useful for this activity to be carried out in the future.

A detailed listing of spills in the files of Metropolitan Toronto and Region of York are given in Table 3.1. This table lists only those spills which occurred in the Don River watershed. Forty-three spills in the watershed occurred in Metropolitan Toronto in 1987; 23 spills occurred in the Region of York in the watershed. The estimate from the Metropolitan Toronto data base include spills which are reported, unreported and/or of unknown origin. The estimates for the Region of York include reported and unreported spills, but do not include spills of unknown origin.

Roughly, the data suggest at least 1 1/4 spills per week in the watershed or 0.1 spills/1,000 people per year. Such a summary does not include seasonal factors and assumes that population rather than length of roadway is a reasonable basis for comparing data between municipalities.

This data base shows qualitatively that there is a much more heterogeneous set of sources in Metropolitan Toronto than the Region of York and that many more of them are industrial or fixed installations in origin in Metro. Inspection of the Region of York data indicates that many are from industrial sources but associated with mobile (transportation related) sources on industrial properties. These data confirm the summary given above that most of the spills in Metro are from fixed sources while most of the spills in the more rural/suburban Region of York are from mobile sources.

3.1.3 Discussion

The results of this work and that of the RAP study permit the following statements.

1. Many of the spills are composed of petroleum or petroleum products. This results from petroleum being a liquid which can move along aquatic pathways and from petroleum being one of the main liquids used in an urban environment.

TABLE 3.1: DON RIVER WATERSHED AREA SPILLS OBSERVED IN 1987

No.	Date	Reach	Substance	Size (S,M,L)	Source (Mobile or Fixed)	Occurrence (Accidental or Intentional)	Response (Reported or Unreported)	Comments
Metropolitan Toronto Data for Don River Watershed								
1	01/01/87	SA	Soap	S	-	-	U	Heavy suds in Massey
2	27/01/87	EG1	Transformer oil	S	F	A	R	From Hydro transformer
3	03/03/87	NB	Caustic	-	F	A	U	(Unc.)
4	30/01/87	TE	Fuel oil	M	F	A	R	Oil tank had hole
5	31/01/87	EI	Gasoline	S	F	A	U	Residual from relacing
6	03/02/87	TB	Light fuel oil	S	-	-	U	Oil slock on Don River
7	10/02/87	EHI	Nathenic acid	-	F	A	U	(unc.)
8	10/02/87	TD	Oil	-	M	A	R	(unc.)
9	20/03/87	TB	-	-		-	U	Orange colour in dor
10	26/03/87	TC	Oil and grease - edible	S	F	I	U	Restaurant dumping
11	27/03/87	TF	Fuel oil	M	F	A	R	Leak inoil tank
12	05/04/87	TH	Transformer oil	S	F	A	R	From Hydro transfer
13	06/04/87	TB	Diesel fuel	-	F	I	U	Suspect dumping to sewer
14	09/04/87	SC1	-	S	-	-	U	White colour in Massey C.
15	11/04/87	SC1	-	S	-	-	U	White material in Massey C.
16	13/04/87	NW	Transformer oil	S	F	A	R	Leak developed
17	22/04/87	TC	Raw sewage	S	-	I	U	Dumping in C/B
18	27/04/87	NR	Gasoline	S	F	A	U	Pipe leak
19	28/04/87	NC2		S	-	-	U	Suds in E. Don River
20	02/05/87	TF	Transformer Oil	S	F	A	U	Transformer leak
21	11/05/87	NP	-	S	-	-	U	Foam in creek
22	13/05/87	VB	-	-	-	-	U	Blue colour in creek
23	27/05/87	TB	Sodium Ethyl Sulphate	S	F	A	R	Overfill tank
24	02/06/87	NR1	Diesel Fuel	M	M	A	R	Valve broke off truck
25	17/06/87	NR	Muriatic Acid (HCl)	S	M	A	U	Bottles broke
26	22/06/87	SA	-	-	-	-	U	Gas odour and oil film in culvert
27	27/06/87	EH1	PCB Contaminated Oil	S	F	A	R	Compactor ruptured
28	02/07/87	TF	Grease-Edible	S	F	I	U	Restaurant dumping
29	03/07/87	TC	Used Auto Oil	S	F	I	U	
30	03/07/87	SA	Raw Sewage	S	F	-	R	Cross-connections
31	03/07/87	TC	Transformer Oil	S	F	A	R	
32	06/07/87	TB	Gasoline	M	F	A	U	Leak during tank excavation
33	23/07/87	TE	Lubricating Oil	S	M	A	U	
34	15/08/87	EG	Concrete Dust	S	F	A	U	Structural work
35	19/08/87	NQ	Magnesium Chloride	S	M	A	U	
36	29/09/87	TF	Gas or Oil	S	-	-	U	(unc.)
37	24/10/87	NO	Oil	S	-	-	U	Oil on Wilket Creek
38	29/10/87	TD	Heating Oil	S	F	A	R	Pumped into house that convert.
39	05/11/87	EGI	-	S	-	-	U	Foam in creek

TABLE 3.1: DON RIVER WATERSHED AREA SPILLS OBSERVED IN 1987

No.	Date	Reach	Substance	Size (S,M,L)	Source (Mobile or Fixed)	Occurrence (Accidental or Intentional)	Response (Reported or Unreported)	Comments
40	10/11/87	TG	Solvent (Turpentine)	S	-	-	U	In C/B
41	16/11/87	NRI	Paint residues	S	F	I	U	From paint spray booth to C/B
42	23/11/87	ND	Light oil	S	-	-	U	Oil in creek
43	03/12/87	TD	Fuel oil	M	F	A	R	Overfill
Region of York Data for Don River Watershed								
1	04/01/88		Fuel Oil	500 IG	Road	Accident		Contained and pumped
2	04/01/88		Gasoline	30 L	Industry	Absorbant		Discharged to creek - Booms & Absorbant
3	15/01/88		Sewage	50 IG	Municipality	Eqpt. malf'n.		Contained
4	04/02/88		Diesel	20 IG	Road	Accident		Absorbed and removed
5	08/02/88		Gas	100 IG	Industry	Tank failure		Contamined soil removed
6	12/03/88		Gas	20 IG	Road	Vehicle accident		Absorbed/removed
7	28/03/88		Sewage	Unknown	Municipality	Eqpt. failure		Suspected bypass
8	09/04/88		Diesel	3000 L	Industry	Eqpt. failure		Absorbants/booms
9	17/05/88		Gas	Unknown	Industry	-		Manhole - detected
10	18/05/88		Gas	Unknown	Industry	-		Suspected leak from storage tank
11	24/05/88		Oil	204	Road	-		Discharged to catch basin - vacuumed out
12	28/05/88		Gas	Unknown	Industry	-		Creek - booms & absorbant
13	29/05/88		Gas	Unknown		-		Continued discharge to creek - unknown source
14	02/06/88		Gas	23,000 L	Industry	Gas bar		Soil removed and vacuum truck - gas bar
15	10/06/88		Oil in creek	Unknown	Industry			Booms and absorbant
16	15/06/88		Road asphalt	20 IG	Municipal			Discharged to watercourse
17	25/06/88		Two barrels - unknown contents	90 IG	Industrial			Removed
18	29/06/88		Diesel fuel	200 L	Roadway	Vehicle accident		Absorbed and removed
19	22/07/88		Gas	40 IG	Roadway	Vehicle accident		Gas siphoned - some absorbed
20	18/08/88		Diesel	5 IG	Roadway			Sanded and removed
21	07/09/88		Cleaning fluid	10 L	Industry			Removed
22	10/11/88		Gas	5 IG	Industry			Roadside spill-work crew removed
23	19/11/88		Diesel fuel	10 IG	Industry			Soil removed

Unc. unconfirmed

2. Industrial land uses are a significant source of spills. Many of the origins of the spills are fixed sources in Metropolitan Toronto. Many of the origins in both Metro and the Region are associated with petroleum products and other mobile sources.

3. Old industrial areas in the Lower Don are associated with unreported, spill like events which reach the river as a discoloured "spike" in the storm sewers. There is a perception that many "unknown origin" spills are observed in new industrial areas, especially from new industrial plazas along small tributaries. The "spill" occurs by accidental or intentional disposal of solid or liquid waste along the back property line of the industrial plaza adjoining the tributary or via transport in storm sewers from floor drains, etc.

4. The success of spills control is reasonably well demonstrated qualitatively; the actual magnitude of spillage (i.e. mass) reaching the river system is unknown.

5. Many spills will be detected by present reporting systems. Many will not be detected, unless an end of pipe or end of ditch audit is made. Such an audit is carried out periodically by North York. Such an audit in association with daily sampling in one of the TAWMS (Humber) catchments showed a surprising number of spills.

   A continuous detective system upon key catchments is one method which can be used to confirm the frequency, the probable magnitude and the constituents of spills reaching the river system.

6. There is a mixed opinion about what would constitute an optimum spills management program. It can be broken down into management and structural elements.

   (a) Structural Elements

   Structural elements would be used to trap spills before they reach the Don River Watershed, particularly along highly prone areas of repeated offenses. They would include:

   (i) spill control, on-line ponds, on ditches along major transportation corridors (highways like 401, rail lines).

(ii) API, oil-water, type separators and/or skimmers on storm water systems draining highly prone industrial areas (e.g. new industrial plazas).

(iii) installation of appropriate structures in old industrial areas as they redevelop.

(iv) spill control ponds upstream of wet ponds installed for other water quality and aesthetic purposes.

(b) Management Systems

Management systems would include the following:

(i) a common data base on all reported spills.

(ii) development of procedures for all fire department crews to contain spill as much as possible. Note: all fire departments do this to a varying degree.

(iii) advising all municipalities on model spills control procedures by MOE.

(iv) investigation of and maintenance of ancilliary equipment on standby at one or two designated centres to be used in support of Fire Department or Works Department response. Investigation of whether this equipment should be integrated with Fire Departments, Works Departments, or maintained at a separate centre.

(v) investigation of the information reported to agencies handling other emergencies (e.g., police, fire department, 911, ambulance) to see if common links can be implemented or whether better information upon initial reporting will assist in the control of spills.

(vi) active follow-up by a designated agency with information relayed back to the Region or local municipality.

(vii) application of industrial data bases available at fire departments to the spills response system; development of these data bases where they do not presently exist.

(viii) uniform training of designated response team leaders and others called in on an "as needed" basis.

Areas highly prone to spills have been identified qualitatively by municipal participants in this study, but are not reported herein because additional analysis of the database is required.

3.2 Evaluation of Impact of Spills Upon Aquatic Ecosystem

Of the wide variety of types of materials in spills, two were selected for evaluation at a microscopic level:

(i) a spill of 100 L of gasoline which was not contained before reaching the river;
(ii) and a CSO overflow of 10,000 m^3 in total volume.

Other petroleum-related impacts such as storage tank leakage to groundwater which may involve up to 30% of the product are not considered in this study.

3.2.1 Petroleum Product Spill

Petroleum and other oil products represent a bewildering array of organic carbon molecules - some in a linear and branched structure, the remainder in aromatic (ringed) structures. Most petroleum products are composed of linear (aliphatic) structures including the following:

Product	Carbon Group	Density
Gasoline	C4-C12	6.2 lb/USGal
Gas Oil & Fuel Oil (#2 oil)	C12-GT C20	-
Kersoene/Light Fuel Oil	-	6.8 lb/USGal
Diesel Fuel/Fuel Oil	C9-C17	7.05 lb/USGal
Aviation Fuel	C9-C10	-
Transformer Oils	C15-GT C20	-

Product	Carbon Group	Density
Lube Oils	GT C20 to approx. C35	7.5 lb/USGal
Residual Oil (#6 Fuel) e.g., Bunker Oil	-	7.9 lb/USGal
Restaurant Oils (vegetable oils)	C8-C15 (app. C-12)	-
Water	-	8.34 lb/USGal

The key to understanding the dynamics of petroleum products is their density and solubility. They are, as indicated above, all lighter than water (Exxon, 1973). They also have limited solubility. Hence, incorporation of such products into the water column involves the formation of mixtures than dissolution reactions.

The toxicity of the different compounds has generally been well established. A comprehensive literature review is not presented here. Rather, a few salient points are made.

(i) All petroleum products which are transported have been distilled and/or cracked (longer molecules cleaved to form shorter molecules) to some degree in the refinery. This results in a range of numbers of carbon molecules in the different structures.

(ii) The aliphatic compounds, particularly the unsaturated linear compounds, are least toxic; the aromatic compounds are most toxic. The larger the number of rings, the greater the toxicity.

(iii) In light petroleum products such as gasoline, the greatest toxicity is associated with BTX. These are B: benzene (C-6), T:toluene (C-7) and X:Xylene (C-8). Benzene is refined as a feed stock for plastics. Its composition in gasoline is as a residual from the refining process. Toluene is added particularly to non-leaded gasoline as an anti-knock agent as the substitute for tetra-ethyl lead ($Pb(C_2H_5)_4$).

(iv) In the heavier fuel products which have been cracked the least in refining processes, the toxicity is caused by larger organic molecules such as the naphenes.

To evaluate the toxicity of a spill, the following assumptions are made:

(i) a spill of 100 L of gasoline, comprised of 3%, 11% and 1% respectively of each of BTX enters a section of the West Don flowing at 100 L/s over a period of 5 minutes.

(ii) The toxic threshold (96 h, LC50) for BTX is the following in Canadian literature.

benzene	100 mg/L	(EC, 1984a)
toluene	10 mg/L	(EC, 1984b)
xylene	8 mg/L	(Trotter, 1984)

(iii) tainting of fish are observed at the following approximate levels after a sufficient time of exposure:

benzene	N/A
toluene	0.25 mg/L
zylene	0.4-7 mg/L

(iv) protection of freshwater fish in the U.S. for shorter-term exposures are the following:

benzene - 3.1 mg/L as 24-hr. average; max. conc. = 7 mg/L
toluene - 2.3 mg/L as 24-hour average; max. conc. = 5.2 mg/L
zylene - N/A

(v) The toxic threshold for short term exposure of fish to a spill is an order of magnitude higher than the 96 hour LC50.

An analysis of the riverine response equations to a pulse injection and the toxic unit approach developed in Supporting Document 2 results in the following contribution to acute toxicity units of one spill:

Contribution	Relative Toxicity Units
Benzene	0.09
Toluene	0.3
Xylene	0.3
Total	0.7

That is a spill of this size would have a reasonable chance of causing an acute toxic response in the fishery, provided that it was intermixed with the water and that the fish would not swim into back waters to avoid it.

3.2.2 CSO Overflow and Stormwater Discharge

To provide a perspective upon the possible toxicity of a petroleum-based spill, it is desirable to relate it to other pulse-like phenomena. A combined Sewer Overflow (CSO) and separated storm sewer discharge were selected for comparison, since each represent a pulse of contaminant loading to a riverine receiving water. They are different from a petroleum-based spill because a spill generally has a small enough volume of liquid that it may not substantially affect the flow rate of the receiving water.

The following assumptions are made for evaluating the impacts of CSO overflows and stormwater discharges. The hydrology of Massey Creek is assumed for the analysis.

(i) the CSO overflow volume is 5,000 cu meters. An event (10 mm) to cause this size of overflow, occurs 8% of the time or less.

(ii) the corresponding volume of runoff in the stream during the 10 mm event from upstream sources is 100,000 cu meters.

(iii) the volume of runoff in the stream from separated storm sewers constitutes 87% of total runoff.

(iv) the SMC's for the CSO overflow has the chemical characteristics and probability of occurrence given in Table 3.2.

(v) the threshold concentration for an acute reaction due to CSO's is an order of magnitude above the 96 hr. LC50 due to kinetic effects of fish uptake (see Supporting Document 2, Section 7) while the threshold for stormwater which passes for a day or so is reasonably described by the 96 hr. LC50.

The resulting assessments are given in Table 3.2 for CSO overflows and in Table 3.3 for stormwater runoff. The chemicals listed in Tables 3.2 and 3.3 are those used in the toxicity model (Supporting Document 2). Only data are available for copper, zinc, TRC (assuming no chlorination of discharges) and ammonia. Other metals may make some contribution to the toxicity. The organics may make some contribution to toxicity, but data describing their concentration levels are lacking at the time of this study.

Overall, the calculations suggest that a CSO overflow associated with a 10 mm storm may pose the same degree risk of acute mortality as is posed by normal stormwater runoff. Most of the risk is associated with copper levels.

This estimate of risk is based upon well-documented threshold values for copper. However, the absolute level of risk posed by these waters may be lower than inferred from the calculations since a substantial portion of the copper may be particulate. Particulate forms of metals pose a smaller risk to fish than if the equivalent concentration is soluble. However, it probably poses an equivalent risk irrespective of whether it is soluble or particulate to other organisms such as daphnia which injest the material.

More work is required in establishing particulate soluble associations and incorporating them into the toxicity evaluation methodology.

3.2.3 Summary

The analyses of this chapter provides a perspective upon the risk to aquatic biota from small petroleum based-spills, CSO overflows, and stormwater discharges. The calculations are considered to be order of magnitude, due to uncertainties in the size of the spill, the concentration variation in the CSO overflows, the concentration variation in stormwater runoff, the thresholds for toxicity, the effect of particulate-soluble relationships upon aquatic toxicity, and the target organisms considered. The calculations suggest that:

TABLE 3.2: TOXICITY EVALUATION OF CSO OVERFLOW

Chemical Constituent	Threshold	SMC'S FOR CSO'S**					
		10th Percentile		Median		90th Percentile	
		Conc.	T.U.+	Conc.	T.U.+	Conc.	T.U.+
Copper (mg/L)	0.9	.16	.11	.35	.24	.75	0.5
Nickel (mg/L)	23	NA	-	NA	-	NA	-
Zinc (mg/L)	9	.22	.01	.35	.02	.54	.04
TRC (mg/L)	0.4	0	0	0	0	0	0
Total Ammonia (mg/L)*	34	0.9	.02	1.9	.03	3.9	.07
Phenol (mg/L)	10	NA	-	NA	-	NA	-
PCP (ug/L)	190	NA	-	NA	-	NA	-
			0.1		0.3		0.6

* pH = 7.8

** Dilution factor of 0.6 is applied assuming that CSO volume passes point in stream in 2 hours while stormwater runoff passes in 24 hr.

+ T.U. is toxicity units defined as the contaminant concentration divided by the threshold toxicity concentration.

TABLE 3.3: TOXICITY EVALUATION FOR STORMWATER RUNOFF

		SMC'S FOR STORMWATER RUNOFF**					
		10th Percentile		Median		90th Percentile	
Chemical Constituent	Threshold	Conc.	T.U.+	Conc.	T.U.+	Conc.	T.U.+
Copper (mg/L)	0.09	.012	0.12	0.34	0.33	.093	0.90
Nickel (mg/L)	2.3	NA	-	NA	-	NA	-
Zinc (mg/L)	0.9	.050	.05	.160	0.15	.50	0.5
TRC (mg/L)	0.04	0	0	0	0	0	0
Total Ammonia (mg/L)*	3.4	.17	0.04	0.4	0.1	0.8	.19
Phenol (mg/L)	1	NA	-	NA	-	NA	-
PCP (ug/L)	19	NA	-	NA	-	NA	-
			0.2		0.6		1.6

* pH = 7.8. Ammonia assumed to be 25% of TKN since ammonia data are not available.

** Dilution factor of 0.6 is applied assuming that CSO volume passes point in stream in 2 hours while stormwater runoff passes in 24 hr.

+ T.U. is toxicity units defined as the contaminant concentration divided by the Threshold Concentration.

- the risk to aquatic biota is similar for a spill of 100 L of gasoline, a CSO overflow or stormwater runoff associated with a rainfall event of the order of 10 mm.

The frequency of occurrence of this size of CSO overflow is 8% or less each year. The frequency of occurrence of a 100 L spill is unclear. However, due to containment, the magnitude is probably less than 100 L. Based upon available data, a spill frequency of 0.1 to 0.5 times/week within a municipality is a probable frequency of occurrence. This is equivalent to 5-25 spills/year.

Since the toxicity of spills is directly related to the magnitude of the spill, information describing the magnitude of the different spills and their frequency of occurrence is required in addition to the chemical constituents of the spill. Such data are not available quantitatively. Accordingly, a frequency approach was adopted in the Fisheries Study (Supporting Document 2). A value of 10 spills per year was chosen as the threshold at which the toxic impact of spills becomes extremely significant.

4.0 EFFECTIVENESS OF CONTROL OPTIONS

4.1 Range of Control Options Presently in Practice

Control options for management of water quality parameters involve a myraid of possible options.

An overview of all possible options is presented in Table 4.1. The many urban, structural and non-structural BMP's considered in the TAWMS (Humber River) study (MOE, 1986) are given in Table 4.2. These options are especially relevant to the retrofit nature of degraded river systems such as the Humber River and the Don River and are a subset of the more comprehensive list given in Table 4.1.

The listing of options include point source control, diffuse source control, control at source and riverine/valley land restoration. They are listed under the following headings:

1. STP Performance
2. Storage and Treatment (CSO Control)
3. Storage and Discharge (Ponds)
4. Flow Control
5. BMPs
6. Other Flow Control Methods
7. Erosion Control
8. Management
9. Urban Maintenance
10. Point Source Control with Stormwater System
11. Physio-Chemical Treatment of Stormwater Discharge
12. Agricultural and Rural Management
13. Fisheries Enhancement/Biological Integrity
14. Public Education
15. Null Option

The methods listed in Table 4.1 are also evaluated according to their probable effectiveness for water quality control. Both flow and removal (R) may improve water quality in the river. Flow control is effective if a relatively contaminated source of flow is permanently removed from the river (e.g., STP effluent diversion) or if flow is directed

TABLE 4.1: MANAGEMENT OPTIONS, REMEDIAL MEASURES; CONTROL OPTIONS FOR WATER QUALITY CONTROL

		Method of* Assessment	Priority (based on effectiveness)		
			H	M	L
1.	STP PERFORMANCE		X		
	- upgrade	R	-		
	- divert to other discharge point	W	-		
2.	STORAGE & TREATMENT (CSO CONTROL)				
	- basins	flow	X		
	- storage in sewer system	flow			X
3.	STORAGE AND DISCHARGE (PONDS)				
	- Dry ponds	R			X
	- Extended ponds	R		X	
	- Wet ponds	R	X		
	- Infiltration ponds	R	X		
4.	FLOW CONTROL				
	- Infiltration Trenches	flow/R	X		
	- On site Water Control	flow		X	
5.	BMP's				
	- On site water control	flow			X
	- Filtered strips	flow			X
	- Grassed swales	flow			X
	- Riparian vegetated strips	flow		X	
	- Reveg. & manage of vegt. areas	flow			X
	- Manage. signif. terrest. areas	flow			x
	- Manage. wildlife habitat	flow			X
6.	OTHER FLOW CONTROL METHODS				
	- Remedial works of downstream channel (traditional-erosion/flood)	bank E			X
	- Berms/dykes	bank E			X
	- Diversions	?			X
	- Porous pavement	flow/R			X
	- Roof leaders to yards	flow/R			X
	- Porous bottom catchbasins (C/B)	flow/R			X
	- Ditches	flow/R			X

* Codes defined on last page

		Priority (based on effectiveness)		
	Method of* Assessment	H	M	L
7. EROSION CONTROLS				
a) General				
- site specific works				
- bank stabilization/french drains	-			X
- horizontal alignment slope control	-			X
- outlet controls	-			X
- buffer strips/set backs	flow			X
- access control				
- urban	?			X
- agricultural	?			X
b) Construction Practices	R	X		
c) Agricultural Management Practices				
- crop rotation	R			X
- no tillage	R			X
8. MANAGEMENT				
- Fertilizer use in watershed	W		X	
- Pesticide/herbicide use in watershed	W		X	
- Land density management				
- density itself	?		X	
- Dist. of land uses	?			?
9. URBAN MAINTENANCE (REMEDIAL PROGRAMS)				
- Urban infrastructure maintenance				
- C/B cleaning	R			X
- street sweeping	R			X
- poop and scoop	R			X
- Oil/water separators	R		X	
- Control illegal cross connection	R		X	
- Spills detection and control	?	X		
- Pond maintenance	W	X		
- Infrastructure Program	flow		X	
- Replacement	flow		X	
- O&M	flow		X	
- Sims Studies	flow		X	

* Codes defined on last page

	Method of* Assessment	Priority (based on effectiveness)		
		H	M	L
- Bylaws				
- - Pet Control	R			X
- - Plumbing Inspection	flow			X
- - Sewer Use	R		X	
- MISA Audit	R	X		
- Hazardous Waste	R	X		
- Infiltration Control of Sanitary Sewers	flow			X
- Aesthetic Cleanup	?			X
10. POINT SOURCE CONTROL WITHIN STORM WATER SYSTEM				
- Industrial cooling water	?	X		
- Industrial floor sweeping practices	?	X		
- Industrial cross connection	?	X		
11. PHYSICO-CHEMICAL TREATMENT OF STORMWATER DISCHARGES				
- Disinfection	R	X		
- Collection/treatment of dry weather flows	W			X
- Chemical precipitation	R	X		
- Water quality inlets	R			X
- Dunkers	R			X
- Swirl Concentrations	R		X	
12. AGRICULTURAL & RURAL MANAGEMENT				
- Conservation tillage				
- Cropping management (erosion)	R		X	
- Direct livestock inputs	W			X
- Destruction of rip. zones by animals	?			X
- Manure storage and handling	R			X
- Rural septic tank upgrades	W			X
13. FISHERY ENHANCEMENT/BIOLOGICAL INTEGRITY				
- Physical habitat (for fish)	?		X	
- Stream temperature control (canopy)	?			X
- Channelization (non-traditional) (improve habitat)	?		X	
- Specific in-stream physical features				
- - pools, riffles	?			X
- - brush bundles/tires	?			X
- - spawning areas	?			X
- Canopy	?			X
- Low flow augmentation	?			X
- Marshland management	?			X
- Organic Matter (Additional Instream Cover)	?			X

* Codes defined on last page

	Method of Assessment	Priority (based on effectiveness) H	 M	 L
- Reaeration	?			X
- Fish ladders	?		X	
- Minimum culvert diameter	?		X	
- Removal of other barriers to fish passage	?		X	
- Set backs (riparian zones)	?		X	
14. PUBLIC EDUCATION	?	X		
15. NULL OPTION	0			X

Legend

R - percent removal
W - loading reduction
Flow - reduction of flow
Bank E - reduction of SS
? - unknown

TABLE 4.2: URBAN STRUCTURAL AND NON-STRUCTURAL BMP'S CONSIDERED IN THE TAWMS (HUMBER RIVER) STUDY

1. Additional enforcement of existing plumbing by-laws
2. Additional enforcement of existing sewer by-laws
3. Disconnection of roof leaders discharging to sanitary sewers
4. Reduce erodibility of surfaces
5. Catch basin cleaning
6. Enhanced street sweeping
7. Sediment control for urban construction
8. Dog litter control programs
9. Bird control measures
10. Disposal facilities/public education re: handling of HC's in the home
11. Stormwater detention ponds for control of runoff and spills
12. Hazardous Contaminants (HC) spills management program
13. Temporary/permanent snow disposal facilities
14. Flushing of combined sewers
15. CSO (combined sewer overflow) interception for treatment, an STP
16. Direct treatment of CSO
17. Flow control at local combined sewers
18. Sewer separations
19. Landfill leachate controls in the flood plain
20. Dredging behind weirs and in the lower river
21. Streambank erosion control
22. Additional flow augmentation from reservoirs
23. Septic tank malfunctions
24. Control storm runoff on new developments
25. Erosion and sediment control on construction sites
26. Flow disinfection

to groundwater before it reaches the river. Removal occurs due to settling reactions or treatment schemes.

All devices and methods, other than flow control, depend upon physio-chemical processes or biological processes to achieve improvements in discharged water quality. As with all treatment schemes, one major factor not adequately considered in any evaluation process is the handling and subsequent disposal of materials removed from the flowing water. This is discussed below in a preliminary way in terms of maintenance and solids handling requirements. In this work, the primary focus is upon removal capabilities because this is the main criteria of interest to this study.

All treatment methods can be classified as passive, passive-active or active. Passive schemes are those which allow natural processes (algal growth, gravity, bacterial dieoff) to achieve removal of contaminants. An example is wet ponds. Passive-active schemes, such as disinfection in conjunction with wet ponds, depend primarily upon passive systems (e.g., processes associated with the pond). But they utilize an engineered system to assist natural processes (e.g., disinfection). Active systems are those which are operated by humans on a continual basis and which achieve most of the removal due to the engineered process. They may depend upon continual inputs of energy to operate. Active systems appropriate for stormwater management are physio-chemical in nature. They include mechanical systems (e.g., swirl concentrators, clarifiers) and mechanical-chemical systems such as flocculation/chemical precipitation with a clarifier or filter.

The control options which will be most effective in improving the Don River water quality are those that influence runoff from separated stormwater systems because other portions of this study have established that they are the dominant source of many of the water quality problems in the Don River Watershed. The origins of contaminants in stormwater from runoff include atmospheric deposition, pollutants washed from urban surfaces, industrial cooling water discharges, leakage into the sewers from cross-connections and other sources, and spills. The quality of this runoff exceeds PWQO's for a variety of substances. Hence, the receiving waters will also exceed PWQO's.

In the future, significant management concerns will be oriented to determining the degree of improvement that the public desires and the amount of treatment required. A reasonable assumption is that the public will desire water quality which approaches

PWQO's for most parameters over a long time frame. The achievement of this may require active treatment of all storm water discharge.

That is, a vision of future stormwater treatment may be one in which a physio-chemical treatment system is applied to all stormwater discharge. This may take the form of a combination of the following: (i) treatment units for certain river tributaries, (ii) interceptor storm sewers to collect discharge from a variety of storm sewers delivering water to a central treatment facility; and (iii) treatment units on other individual outfalls. This may require a rethinking and redesign of storm sewers to be closer to that of a sanitary sewer system: collection to centralized facilities, rather than the multitude of sources presently in place.

This document does not make a decision on this possible vision. Rather, it accepts the findings of this study that some degree of treatment of all stormwater runoff is presently required to attain a significant improvement in water quality. The possible effectiveness of various control measures are evaluated in Supporting Document 1. However, most of the control measures evaluated are in the passive category (for most contaminants) or passive/active category (for bacterial control by disinfection). Decisions will need to be made in the future about the need for "active" treatment techniques for most stormwater runoff after the effectiveness of the presently proposed strategies have been audited after their implementation and in light of cost factors and the nature of public concerns.

4.2 Control Options for Spills

Control options for spills include:

- management systems for responding to spills;
- management systems for planning for spills;
- in place structural control options at locations with high probability of occurrence; and
- portable control units for responding to specific sites of spills occurrence.

4.3 Description of Control Options of Rural Areas

The main "rural" regions of the watershed are located in the headwater areas of the Don River. Much of the formerly agricultural land is inactive, being held for urban development. While the rural portion of the watershed is small (agricultural areas less than 5% at present), control options for rural areas were considered to address all non-point sources and to provide a background to the effectiveness assessment given in Table 4.1.

The variety of agricultural and rural management practices which could be considered include the following:

1. Structural measures for erosion control;
2. Grass crops (e.g., hay) and/or crop rotation;
3. No tillage methods for row crops;
4. Grassed strips and canopies along the stream;
5. Cattle access control;
6. Manure storage and spreading methods;
7. Disconnection of illegal connections to drainage tile;
8. Disinfection at rural beaches;
9. Fertilizer use; and
10. Public Education (particularly options of Environmental Preference).

The GAMESP model was used previously to evaluate the impact of different agricultural management practices upon suspended solids erosion and total phosphorus export from agricultural watersheds. The present mix of crops in York County was used in the base case. The present mix of crops for York County is as follows:

o	soy beans	8.6%
o	corn	32%
o	cereals	30%
o	hay and grasses	29%

Five farm management systems alternatives were evaluated for their effect on soil loss, sediment delivery and phosphorus loss. These include:

(i) conventional farming;
(ii) residue management for both row crops and grains;
(iii) no-till system for row crops and residue management on all grain crops;

(iv) target area (high erosion potential) management including all areas over 10 tonnes/ha; and

(v) target area management including all areas over 6 tonnes/ha.

The type of farm management system refers to the type of tillage system used, time of tillage and whether residues or some other soil cover are present at critical times of the year. Conventional management systems consist of fall moldboard plowing, discing once or twice in the spring and does not have a soil residue cover. Residue management, in this modelling exercise, refers to a crop residue left on the field after harvest providing significant soil cover protection inhibiting both raindrop detachment and overland flow sediment carrying capacity. No-till systems refer to the direct planting of crops into the previous year's crop cover.

The major effect of options 1 and 3 is to cover the probable range between completely exposing the soil to the erosional processes to minimizing agricultural to erosional processes within the limits of a commercial agricultural system. Two levels of protection which minimize agricultural erosional processes and which are more effective than those considered in this study include permanent pasture and reforestation, neither of these two methods are plausible alternatives for commercial agriculture.

Option 3, no tillage, represents the one method for minimizing the opportunity for erosion in row crops. It involves planting seed directly into the ground without prior plowing/cultivation and maintaining trash from previous rowcrops as a cover to minimize erosion. In this manner, it approaches the minimum erosion potential of hay and similar grass crops. From a water quality point of view, it potentially suffers from its dependence upon herbicides to control weed quality, a dependence which is partially controlled by plowing and cultivating in other practices. However, the increased application of herbicides in "no tillage" is not excessive in comparison to the application rate used for monoculture practice (e.g., for corn crops).

Other control options such as the effect of buffer strips, planting a canopy, or preventing cattle access to the dendritic streams flowing through farm land were not evaluated due to the lack of literature which indicate their effect upon controlling erosion. However, recently literature indicates that the effects of these options have been documented in a New England EPA study - these options have a noticeable impact in the short-term. The role of canopy in mitigating temperature for lake fishery, is, however, considered in a later section.

Other controls considered in the TAWMS (Humber River) study include manure storage and spreading methods and disconnection of illegal connections to drainage tile.

The effect of the different management options on water quality are summarized in Table 4.3. The two primary options (residual management, no till) have comparable impacts upon suspended solids and total phosphorus. However, use of target areas has a widely varying effect. This results from the differences in the two sub-watersheds related to the larger slopes in sub-watershed No. 1 and the location of erosion prone areas further from the stream channel in the watershed No. 1. Average values of these reductions are used for Table 4.4.

4.4 Description of Control Options for Urban Systems

4.4.1 Assumptions Used to Delimit Control Options Considered

There are a variety of control options available for improving water quality influenced by urban sources. In establishing control options for consideration in this study, several assumptions about future water management policies were made which narrow down the list of options ultimately considered. The assumptions include the following:

1. All future urban sewer systems will be completely separated with appropriate by-laws for maintenance of these systems strictly enforced. (This includes non-connection of roof-leaders to sanitary sewers.)

2. All water supply to the urban areas will be derived from outside the watershed (i.e., Lake Ontario); all new wastewater treatment plant effluents will be discharged to outside the watershed (i.e., to Lake Ontario).

3. There will be no new combined sewer overflows (CSO's) permitted in the watershed. The present policies of separating sewers and present studies and programs aimed at controlling present CSO's are acknowledged.

TABLE 4.3: SUMMARY OF EFFECT OF AGRICULTURAL MANAGEMENT UPON TOTAL PHOSPHORUS AND SUSPENDED SOLIDS EXPORT

	WATERSHED 1		WATERSHED 2	
Agriculture Management Practice	Suspended Solids % Reduction	Total Phosphorus % Reduction	Suspended Solids % Reduction	Total Phosphorus % Reduction
Conventional	-	-	-	-
Residual M.	19	42	17	50
No Tillage	61	81	29	73
Target Areas (10 tonne/ha)	16	30	7	17
Target Areas (6 tonne/ha)	-	-	11	32

4. There is one large landfill in the watershed (Maple) nearing the end of its life, and a variety of old landfills and dumps. Their leachate, if established as significant in future studies, may need additional treatment. New landfills are not considered in this study, because their location will be a political decision, after consideration of environmental constraints at the candidate location. Accordingly, it is not possible to decide whether the landfills for several area municipalities would be located within or exterior to the Don River watershed.

4.4.2 Description of Selected Control Options for Urban Systems and Their Effectiveness

The following control options are now described in more detail.

1. Stormwater detention ponds;
2. Disinfection of storm pond discharges;
3. Infiltration devices;
4. Chemical precipitation/flocculation of storm ponds;
5. Catch basin cleaning;
6. Enhanced street sweeping;
7. Dog litter and bird control methods;
8. Hazardous contaminant and hydrocarbon (HC) spill management from mobile and stationary sources;
9. Implementation of oil separators of gasoline station discharges;
10. Collection of initial storm runoff;
11. Retrofitting;
12. BMPs and Innovative Approaches;
13. Physio-Chemical Treatment; and
14. Novel Urban Design.

1. Retention - Detention Ponds

Retention or detention facilities could be constructed at several locations within the watershed. Retention-Detention Ponds are also known as Best Management Practices (BMPs). Their performance is critiqued below under heading 12 and in Section 5.0.

2. Disinfection

Disinfection of individual outlets, of multiple outlets, or of storm ponds were considered. Disinfection of individual stormwater outlets in the Don River system is infeasible. This limits disinfection to storm ponds discharges for achieving a swimming end use. Several alternative methods for disinfection are available, including ozonation, ultraviolet irradiation and chlorination. Disadvantages of chlorination include chemical handling and chlorination by-products (e.g., chlorinated organics) and the effects of chlorine residuals upon fish. Disadvantages of ultraviolet irradation include lowered efficiencies in turbid water and power costs. Disadvantages of ozonation include chemical supply (e.g., the need to make ozone at the site of application) and electrical power requirements. A minimal amount of modelling of storm sewer system would be useful; an assumption about the efficiency of disinfection were made based upon literature data (see Table 4.4).

3. Infiltration Devices (On-Site Infiltration; Off-Site Infiltration)

Infiltration devices direct flow into the ground through percolation into soils. Devices in use include infiltration trenches and infiltration basins. They provide water quality control by substantially reducing the volume of runoff, somewhat reducing the peak flow rate and hence reducing the loading. If the infiltrating runoff reappears in the watershed, it occurs during low flow periods to augment base flow levels and is of a significantly better water quality due to removal of metals, nutrients and organics by sorption onto soil solids and due to its lower temperature.

Infiltration devices appear, however, to a relatively poorer technology for overall water quality control because of their short lifetime. This is caused by plugging the soil pores by silt particles to reduce their infiltration capability, often turning them into marshes. Key parameters in assessing their viability include:

- the need for soils with a high permeability (e.g., sands, sandy silts);
- the small watershed area practically served by a device (e.g., 2-10 ha for infiltration basins;
- the annual variation in water table levels and the depth to groundwater table; and

TABLE 4.4: EFFECTIVENESS OF CONTROL OPTION

Option	Effect on Runoff Volume	Effect on Concentration
1. AGRICULTURE		
1.1 Residual Management	Nil	TP - 46 percent decrease SS - 18 percent decrease
1.2 No tillage	Nil	TP - 77 percent SS - 45 percent
1.3 Target Areas (10 tonne/ha)	Nil	TP - 23 percent SS - 13 percent
1.4 Target Areas (6 tonne/ha)		TP - 45 percent SS - 17 percent
2. URBAN AREAS		
2.1 Control ponds	Nil	SS - 90% Bacti - 50-90%
2.2 Disinfection	Nil	SS - Nil Bacti - 99%
2.3 Infiltration Devices	60%	—
2.4 Chemical Precipitation	Nil	Pollutant Mass (kg/ha)

	No Tmt	Settling Only	Alum Floc
TSS	316	40	16
BOD_5	14	8.6	4.3
COD	180	77	68
TP	0.20	0.10	0.04

Storm events with runoff volume greater than 3.5 cm (73% of observed runoff volume) contributed 92%, 88%, 86% of SS, BOD_5 and COD pollutant mass loads.

Option	Effect on Runoff Volume	Effect on Concentration
2.5 Catchbasin cleaning	Nil	1-5%
2.6 Enhanced street sweeping	Nil	1-5%
2.7 Litter control	Nil	20% reduction of fecal coliform
2.8 HC spill management	Nil	Qualitative Assessment
2.9 Oil water separators at Gasoline stations	Nil	80% reduction

TABLE 4.4 (cont'd) EFFECTIVENESS OF CONTROL OPTION

Option	Effect on Runoff Volume	Effect on Concentration
3. INNOVATIVE TREATMENT		
3.1 Ditches	10% reduction	30% reduction of SS (assumed)
3.2 Alternative urban design	20% reduction	30% reduction of SS, TP and all metals associated with SS

- general maintenance requirements.

The effectiveness of different designs is given in Figure 4.2 (see discussion of BMPs below). For purposes of this study, it was assumed that chemical constituents of infiltration waters were completely removed and that 60% of runoff served by infiltration devices infiltrated into the ground, dependent upon the magnitude of the stormwater volume.

4. Chemical Precipitation/Flocculation

Chemical precipitation occurs following the addition of coagulants such as alum or iron chloride to water. The coagulant also enhances suspended solids settling in control ponds by flocculating small solids (e.g., clay size) into larger aggregates, which settle more readily. It also has the added advantage of chemical coprecipitation of some trace metals and trace synthetic organic chemicals. Literature estimates are available to characterize its effectiveness for suspended solids settling in storm ponds (Kronis, 1982), but not for metals removal. Hence, consideration of this option is restricted to the parameters given in Table 4.4.

5. Catchbasin Cleaning

More frequent catchbasin cleaning may lead to reducing the pollutant loads to the receiving body. Furthermore, increasing the frequency of catchabasin cleaning should reduce sewer clogging in problem areas. The estimates of effectiveness given in Table 4.4 were based upon the TAWMS summaries.

6. Enhanced Street Sweeping

A literature review for street sweeping shows that there are varying opinions as to the effectiveness of this option. There are four methods for street sweeping; mechanical, manual, vacuum, and combined vacuum/mechanical. Literature values were used to establish the values given in Table 4.4 for this option.

7. Litter Control

Possible sources of litter include animal (e.g., dog dropping), leaf litter (in the autumn), and human litter (e.g., coffee cups, fast-food bags) disposed from cars and by pedestrians. Droppings can be controlled by bylaws. Human litter is minimized by providing trash baskets at frequent intervals. Litter control could be modelled as a percent removal of potential mass disposed on the catchments during inter-event periods, and by assuming that runoff has a certain removal efficiency of the remainder during the event. Such modelling was beyond the scope of this work. The values from TAWMS were used in this study.

8. Hazardous Contaminant and Hydrocarbon (HC) Spills Management

This involves the implementation of contingency plans to handle spills and the residential discharge of other hazardous substances. From MOE data (which document intermediate to major spills), the TAWMS studies on the Humber River indicated 0 to 6 spills per week, with 46 spills of these sizes documented over a 5 year period. Most of the spills resulted from transportation connections, gasoline stations, and residential oil spills.

Undocumented, but observed by water quality monitoring personnel on the Humber River, are a large number of small spills per week in various storm sewers. In some instances, the end result was that there was almost a continuous sheen of oil/grease/gasoline flows in various sections of the Humber.

In addition, the spring time is particularly susceptible to washoff of accumulated hydrocarbons. Such phenomena, particularly washoff of accumulated winter deposits, would more appropriately be classified as "road runoff", i.e., an urban non-point source than spills. Irrespectively, such occurrences still require management.

In the TAWMS study, the writer (Control Option 12, OME, 1986) suggests that the City of Scarborough has one of the best contingency plan in the Metropolitan Toronto area for the control of spills. Estimates developed in this present study indicate that the following sources supply most of spills entering the river system:

- mobile transportation sources,
- gasoline stations, and
- residential and industrial areas,

One major weakness to these estimates is the known occurrence, but unmeasured quantity of petroleum products found in stormwater runoff not resulting from spills. These result from car leakage and asphalt leaching and subsequent washoff by lawn watering or rainfall. One U.S. EPA study indicates that 35% is due to cars and asphalt in one American city.

A reasonable assumption is, however, that the major spills account for up to 95% of the total potential hydrocarbon products which would be discharged due to spills.

Qualitative assessments were used to establish the effectiveness of spills management in the HSI study (Supporting Document 2).

9. Oil Separation at Gasoline Stations

One of the previously identified major sources of petroleum products entering storm sewer systems is the accidential spillage of petroleum products. Control of such spillage can be achieved by placing oil/gasoline separators on the stormwater outlets. The other major identified problem associated with gasoline stations is the corrosion of storage tanks and the subsequent leaking to groundwater. The U.S. EPA has a program to address this problem entitled, "LUST: Leaking Underground Storage Tanks". An equivalent program was not identified in Ontario except that the issue falls partially within the jurisdiction of the Fuel Safety Branch at MCCR (Ministry of Consumer and Corporate Relations).

In this study, it is assumed that proper planning will prevent corrosion of underground trenches, resulting in the oil separators being the only required control method.

The degree of control given in Table 4.5 assumes 80% removed effiency for oil-water separators. This is a conservation value, given that manufacturers claim a wide spectrum of efficiencies from 80% to 99%.

In addition to implementation of the separator, ongoing maintenance to remove accumulated petroleum products are required. The costs of this activity are estimated.

10. Collection of Initial Storm Runoff

The objective of this option is to collect a specified percentage of the storm sewer flow from a series of outlets. These flows would then be directed to an in-system facility or to the STP for treatment. Collection of the initial flows would, in theory, significantly reduce the pollutant loading to the receiving body. A preliminary analysis indicated that this option would have limited feasibility, because it is particularly applicable to combined sewers. The option was not considered further.

11. Retrofitting

Retrofitting involves modifying the existing sewer system to improve the water quality. This could include providing offline storage and treatment in underground or above ground facilities or utilizing existing park or open space areas as dual facilities. The facilities would continue to serve their existing use and also act as a facility for providing water quality treatment. This option may prove to be useful in specific locations. Some modelling of this control option would be useful to establish the sizing of the proposed facility.

In this study, the effectiveness and associated costs were estimated on a watershed wide basis.

12. Best Management Practices (BMPs) and Innovative Approaches

A variety of urban BMP designs were qualitatively evaluated by Schuler (1987). A summary is provided in Figure 4.2. Such an approach for information presentation by tributary or river reach would also be useful. Two BMPs, wet ponds and infiltration basins have also been described above.

Ditches represent one alternative to storm sewers for transport of urban runoff. Ditches are not generally accepted in newer developments by municipalities, but they exist in extensive areas of older developments in municipalities such as Etobicoke. They also occur along major freeways such as the 401, 427, etc. Use of ditches to improve water quality control requires additional design thinking, particularly for highway areas prone to spills. Coordination between MOE, Municipal Roads Department and the MTC re: environmental easements and buffers at the design stage would improve their control capabilities.

Based upon the assumption that ditches collect water from 40% of the area of an urban area, the quality and quantity reductions given in Table 4.5 are assumed. The impact on quality is assumed by inspection of Figure 4.2, and an assumption that ditches are similar to filter strips/grasses swales.

For alternative urban design, the design selected involves narrow streets and catch basins draining first to filter strips and then to grassed swales. Inspection of Figure 4.2 was used to make the estimates given in Table 4.4.

13. Physiochemical Treatment of Stormwater

Processes employed in water treatment and wastewater treatment plants have also been considered for direct treatment of CSO's and stormwater. These include:

- disinfection (chlorination, bromination, ozonation; for bacterial control);
- chemical precipitation/flocculation (for suspended solids control and for chemical precipitation of phosphorus and metals); and
- industrial organics and SOC (Synthetic Organic Chemical) removal.

There are a variety of techniques available for removing organics including:

- oxidation and/or coagulation,
- activated carbon adsorption,
- air stripping, and
- ion exchange.

The potential technology which may be used for specific organic compounds is summarized in Figure 4.3 as a function of solubility and molecular weight of the compound.

Other considerations in implementing such techniques include the impact upon water quality and fisheries of chemicals added and the changing of the point of impact from water to air in the case of air stripping.

Fig. 4.2: Comparative Pollutant Removal Of Urban BMP Designs

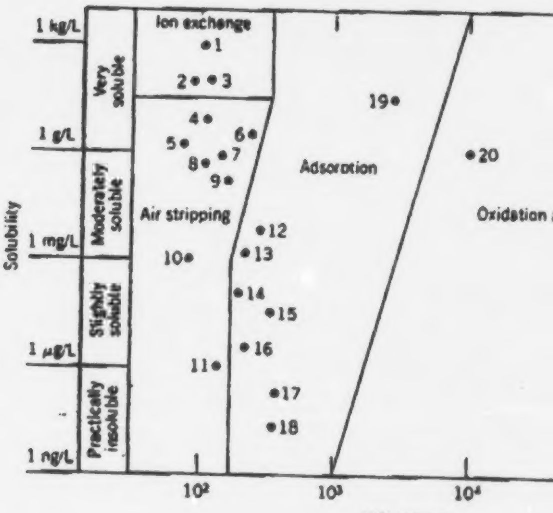
BMP/design	SUSPENDED SEDIMENT	TOTAL PHOSPHORUS	TOTAL NITROGEN	OXYGEN DEMAND	TRACE METALS	BACTERIA	OVERALL REMOVAL CAPABILITY
EXTENDED DETENTION POND							
DESIGN 1	◕	◔	◔	◔	◑	⊗	MODERATE
DESIGN 2	●	◑	◔	◑	◕	⊗	MODERATE
DESIGN 3	●	◕	◑	◑	◕	⊗	HIGH
WET POND							
DESIGN 4	◕	◑	◔	◔	◔	⊗	MODERATE
DESIGN 5	◕	◑	◔	◔	◕	⊗	MODERATE
DESIGN 6	●	◕	◑	◑	◕	⊗	HIGH
INFILTRATION TRENCH							
DESIGN 7	◕	◑	◑	◕	◕	◕	MODERATE
DESIGN 8	●	◑	◑	◕	●	◕	HIGH
DESIGN 9	●	◕	◕	●	●	●	HIGH
INFILTRATION BASIN							
DESIGN 7	◕	◑	◑	◕	◑	◕	MODERATE
DESIGN 8	●	◑	◑	◕	●	◕	HIGH
DESIGN 9	●	◕	◕	●	●	●	HIGH
POROUS PAVEMENT							
DESIGN 7	◑	◕	◑	◕	◑	◕	MODERATE
DESIGN 8	●	◕	◕	◕	●	●	HIGH
DESIGN 9	●	◕	◕	●	●	●	HIGH
WATER QUALITY INLET							
DESIGN 10	○	⊗	⊗	⊗	⊗	⊗	LOW
FILTER STRIP							
DESIGN 11	◔	○	○	○	◔	⊗	LOW
DESIGN 12	●	◑	◑	◕	●	⊗	MODERATE
GRASSED SWALE							
DESIGN 13	○	○	○	○	○	⊗	LOW
DESIGN 14	◔	◔	◔	◔	○	⊗	LOW

KEY:

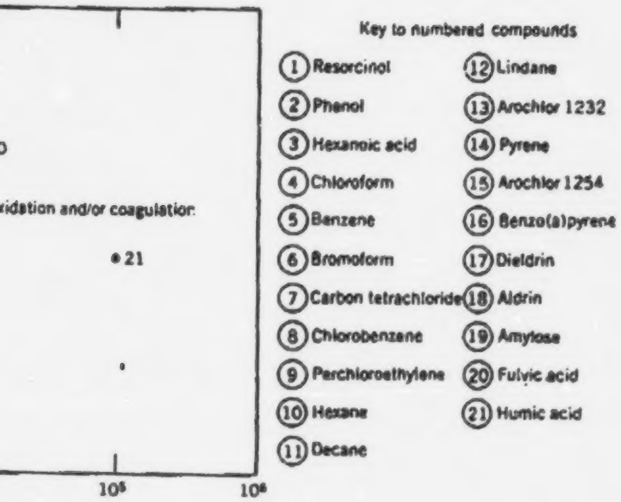
- ○ 0 TO 20% REMOVAL
- ◔ 20 TO 40% REMOVAL
- ◑ 40 TO 60% REMOVAL
- ◕ 60 TO 80% REMOVAL
- ● 80 TO 100% REMOVAL
- ⊗ INSUFFICIENT KNOWLEDGE

Design 1: First-flush runoff volume detained for 6-12 hours.
Design 2: Runoff volume produced by 1.0 inch, detained 24 hours.
Design 3: As in Design 2, but with shallow marsh in bottom stage.
Design 4: Permanent pool equal to 0.5 inch storage per impervious acre.
Design 5: Permanent pool equal to 2.5 (Vr); where Vr=mean storm runoff.
Design 6: Permanent pool equal to 4.0 (Vr); approx. 2 weeks retention.
Design 7: Facility exfiltrates first-flush; 0.5 inch runoff/imper. acre.
Design 8: Facility exfiltrates one inch runoff volume per imper. acre.
Design 9: Facility exfiltrates all runoff, up to the 2 year design storm.
Design 10: 400 cubic feet wet storage per impervious acre.
Design 11: 20 foot wide turf strip.
Design 12: 100 foot wide forested strip, with level spreader.
Design 13: High slope swales, with no check dams.
Design 14: Low gradient swales with check dams.

Fig. 4.3: Removal of Organic Compounds



unds for Various Technologies



Such effects need to be considered in screening studies preparatory to implementing such techniques.

14. Novel Urban Design

Other innovative urban designs were considered. They include the provision of ditches instead of storm sewers in appropriate urban densities (e.g., estate development, low density housing) and cluster urban designs in which all urban runoff is passed through grassed yards to wetlands before the wetlands flow into normal drainage ditches.

5.0 WET PONDS

One of the key findings of this study is that control of stormwater runoff from separated sewer systems is required to achieve significant improvement in riverine water quality. Significant control can be achieved using passive systems. But the passive systems must be a wet pond, an extended wet pond or equivalent.

The terminology "wet pond" or equivalent" is a key, deliberate phrase. This terminology was selected because it provides substantial "treatment" benefits for pollutant removal while being relatively inexpensive compared to other technologies like physio-chemical techniques. If new technologies evolve in the future which give the same degree of treatment, then the strategy would indicate that these "or equivalent" technologies could be readily substitued.

Selecting locations for wet ponds in the Don River watershed will be a key next step. Given the over 1300 stormwater outlets in the Don River watershed and the roughly 200 ponds suggested for implementation (see summary report), 5-10 outlets would be need to be served by each pond. Not all outlets would need wet ponds, since some would be served by infiltration devices or other combination of BMPs and possibly source control. Accordingly implementation will require identification for possible locations, since all outlets will need to be controlled in the future in order to achieve probable levels of protection. Implementation will occur over long periods of time in some areas where physical space is not available and hence where plan implementation may have to await opportunities afforded by redevelopment. This process would be assisted by insuring that chicken-pock redevelopment is not allowed in areas adjoining possible locations for "wet ponds or equivalent", or other BMPs.

This section documents key features of stormwater management facilities related to historical design, water quality performance, and conflicts associated with wet ponds.

5.1 Current Municipal Practice

Several Ontario municipalities have adopted policies of constructing ponds along streams and drainage ditches that have widely varying hydrographs due to rapid runoff of stormwater from urban and other developed lands. The function of these ponds is to provide temporary storage of water so that downstream watercourses are buffered against these rapid changes in discharge. Storm ponds have typically been constructed in areas of new development, where increased imperviousness has greatly enhanced the rate of runoff and erosion of surface soils. Storm pond designs vary in their stated degree of control sought, but typically attempt to ensure that the peak runoff rate after development is similar to that before development. Dependent upon watershed characteristics and area, this ensures differences in morphometry (depth, area), structural attributes, and the quantity of water held during runoff and low flow conditions.

SWM ponds offer potential for water quality improvement, by promoting sedimentation of suspended solids and sediment-associated contaminants, such as heavy metals and trace organics. Contaminants that are loosely or reversably absorbed to those sediments may be subsequently released back into the water. Historically, storm ponds have not been designed for water quality control, but nonetheless, may still provide this function.

Storm ponds may also provide suitable habitat for certain species of aquatic life and wildlife. In many wet ponds, areas may become colonized by emergent aquatic plants, such as cattails, and may provide suitable habitat for certain warmwater fish, aquatic invertebrates and waterfowl. These ponds thus provide a direct biological role within the stream ecosystem. Such ponds provide useful aquatic habitat in areas where such habitats are often very scarce, and may be perceived as desirable urban features by naturalists and other members of the public. On the other hand, dry ponds that hold no water between runoff events, provide almost no habitat suitable for fish, wildlife or plants.

5.2 Historical Design

Storm ponds have traditionally been designed to achieve reduction in peak flow rates of hydrographs (DiToro and Small, 1979; Driscoll, 1986; Huber et al., 1982; Rowney and Wisner, 1984; BEAK and MMM, 1988). The ponds fall into two major types:

(1) dry ponds, and
(2) wet ponds.

The ponds have been designed to be either on-line (on the main stem) or off line (off the main channel although perhaps on a side tributary).

Control ponds are typically designed, in the Toronto area, to provide control for a particular return period. While 1 in 2 year control is used for many ponds, inspection of the design characteristics of ponds indicate that a variety of return periods has been used ranging from 1 in 2 year control to 1 in 100 year control. The designs for one watershed near the Don River have the following range:

Design Frequency	Number of Ponds	Percent of Ponds
1 in 2	8	25
1 in 5	4	12
1 in 10	0	0
1 in 25	3	10
1 in 100	17	53

The ponds have traditionally been designed using the design storm approach. This involves:

i) using the single-event, design storm characteristics (and the associated return period) to estimate the peak runoff rate and runoff volume before development;

ii) estimating the changes to the hydrograph due to the proposed development; and

iii) then sizing the control pond to give a hydrograph whose peak flow is similar to before development.

Another approach which has been advocated is that of continuous simulation. This approach theoretically gets better estimates of inter-event moisture content and a more realistic picture of the effect of the storm pond on the complete spectrum of hydrographs. However, the recent work has called into doubt the ability of some models such as the HYMO class to correctly forecast moisture content over long simulation periods. A water budget model such as HSPF (BEAK, 1986) is required for such calculations.

The hydraulic performance of ponds, in comparison to design specifications, has not been evaluated in any case studies available to us. However, relative to other issues (water quality, sedimentation etc.) where measurements are required to validate pond performance, measurement of the hydraulic performance of ponds (i.e., measured inflow and outflow rate) is less important because models of pond hydraulics are relatively quite accurate. The factors which will affect hydraulic pond performance are:

i) the rate of sedimentation;
ii) the frequency of blockage of the outlet structure by debris; and
iii) the change in influent channel cross-sectional area due to geomorphological progression.

None of these factors has been measured in the ponds in the Don River, to our knowledge. Accordingly, their impact upon hydraulic performance cannot be evaluated other than in general terms. The type of blockages which occur have been observed for representative ponds of the Don River. Sedimentation rates in reservoirs receiving runoff from eroding areas may be of the order of 10 cm/yr. This rate is a function of the erosional characteristics of the watershed; the particle size distribution; the ratio of area of the drainage area of the watershed and surface area of the reservoir; and the amount of reshaping (erosion of shore areas and deposition in lower layers) occurring in the reservoir or pond.

For these estimates, a substantive change in storage volume should occur in the wet ponds while a very small change would occur in the dry ponds.

5.3 Water Quality Performance

Contaminants introduced onto the pond are removed to the sediments if attached to particulates. Most of this removal occurs by settling during and immediately after a runoff event. Sediment erosion caused by wind driven currents; release of contamination from sediments by diffusional processes; and uptake by vegetation from sediments and their subsequent decomposition are mechanisms for releasing contaminants from the pond sediments into downstream waters. Atmospheric deposition and volatilization are mechanisms which may also influence contaminant fluxes in ponds, particularly for volatile industrial organics and synthetic organic chemicals (SOC's).

Monitoring of contaminant concentrations flowing into the pond and from the pond are required in order to evaluate water quality performance where water quality performance is defined as the net removal of contaminants. Little performance monitoring data are available for reservoirs or ponds in the Don system. Accordingly, literature data must be used to provide some guidance.

The performance of ponds/urban marshes/reservoirs was assessed in the NURP study (see Figure 5.1). Only lead, TP and total suspended solids were assessed in a comprehensive fashion. The results indicate the following levels of contaminant removal typically occur in urban ponds.

lead	10-90%
phosphorus	0-80%
suspended solids	10-95%

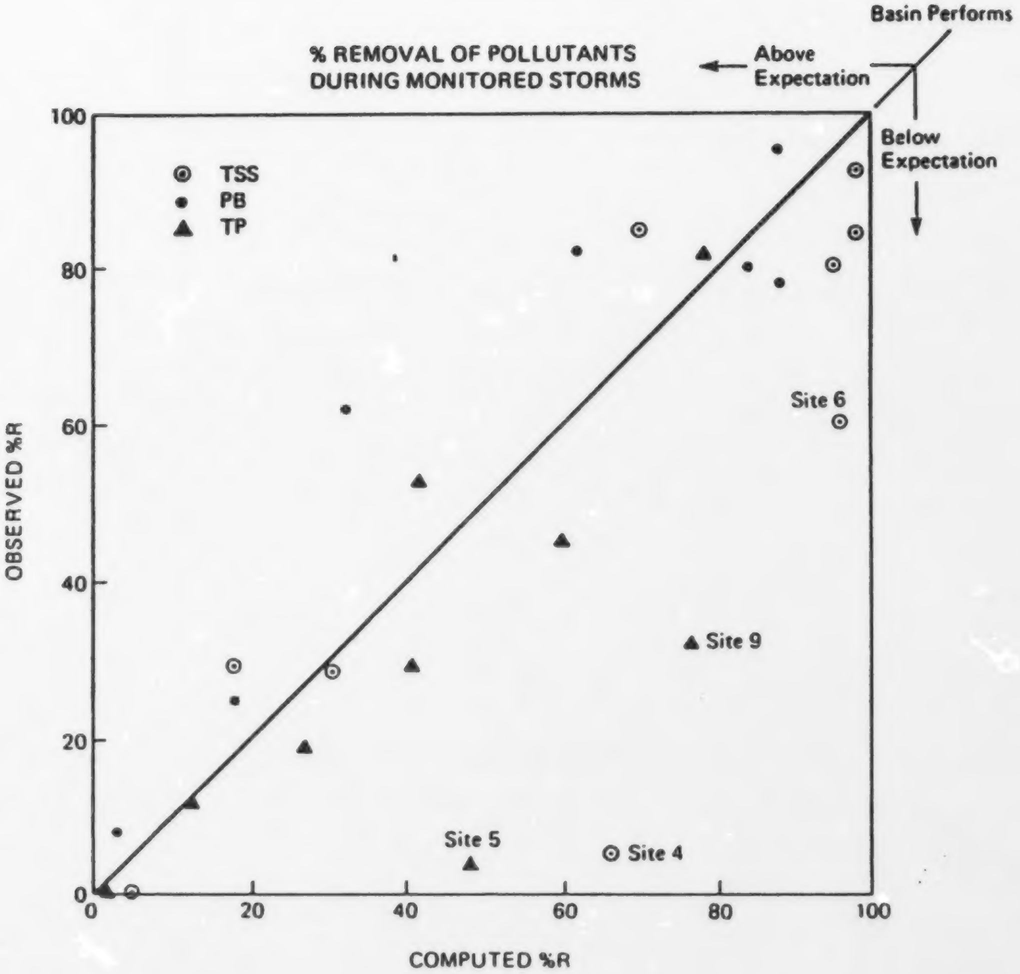
A model based upon the percent of the contaminant which is particulate, the settling velocity of the particulate phase, the mean depth of the pond, and hydraulic loading to the pond, was used by Driscoll (1986) to predict removals during storms. The computed percent removal is given along the X-axis in Figure 5.1, the observed percent removal is plotted along the Y-axis. A perfect model would follow the 1:1 line.

The results indicate that the model predicts removal in a reasonable fashion for suspended solids, total phosphorus and lead for 9 ponds. There are four exceptions to this predictive ability of the model out of 27 predictions: predictions for total phosphorus in two ponds, and predictions for suspended solids in two ponds. Satisfactory explanations are provided for all 4 exceptions. For example, in one case, total phosphorus removal was dominated by marsh grasses.

Based upon the success of this type of predictive model, and other monitoring data, Schueler (1987) has used this pond-removal-model to classify the ability of various pond designs and other best management practices to remove contaminants. Removals have been broken down into 6 categories:

1. 0-20% removal
2. 20-40% removal

FIGURE 5.1: COMPARISON OF MODEL PREDICTIONS WITH OBSERVATIONS FOR REMOVAL OF SS, TP AND Pb IN STORM WATER PONDS (AFTER WOODWARD-CLYDE, 1986)



3. 40-60% removal
4. 60-80% removal
5. 80-100% removal
6. Insufficient knowledge

The removals are given above in Figure 4.2 for six classes of contaminants. They are:

1. suspended solids
2. total phosphorus
3. total nitrogen
4. oxygen demand (BOD, COD, TOC)
5. trace metals
6. bacteria

The overall removal capabilities for all six classes of contaminants are as given as: high, moderate, or low.

Removal estimates are given for the following types of ponds and BMP's in Figure 4.2.

1. extended detention ponds
2. wet ponds
3. infiltration ponds
4. infiltration basins
5. porous pavement
6. water quality inlet
7. filter strip
8. grassed swells

The treatment efficiency (i.e., percentage removals obtained) ranges from moderate to high for extended detention ponds to low for water quality inlets, filter strips, and grassed swales.

5.4 Sedimentation Patterns

5.4.1 Introduction

SWM ponds tend to accumulate sediments rapidly (Hey, 1986; Huitved-Jacobsen et. al., 1987, Randall et. al., 1986, Schueler 1987, particularly in watersheds where land-clearing and construction are widespread. The rate of sedimentation depends not only on *sediment loading from upstream, but also on specific characteristics* of each pond in terms of peak flow velocity and turbulence in the pond. Wet ponds accumulate sediments much faster than dry ponds because suspended sediments are drained from dry ponds between runoff events. While sedimentation may be desirable in terms of downstream water quality, it eventually results in the need to remove these deposits in order to allow them to fulfil their treatment objectives.

SWM ponds act as sinks for sediment-borne contaminants such as heavy metals and toxic organic compounds. These materials are available to pond-dwelling organisms, and may be remobilized back into solution. If a pond acts as a net repository of waterborne contaminants, this will result in an overall decrease in waterborne contamination downstream.

5.4.2 Sedimentation Dynamics

Ponds show a discontinuity in a core profile between the depths of soft surficial sediment measured, and the underlying glaciated soils. Measurement of sediment accumulation, allows evaluation of storm pond design and outflow characteristics, as it relates to the pond and the history of upstream activity. Larger particles settle in the delta area of the inflow stream while smaller particles settle near to the control structure or pass through the pond. At some level of sediment in-filling, the rate of sediment input to and export from the pond will reach an equilibrium, depending on design features, so that it no longer functions as a sediment trap. Data to describe these dynamics and their implications for the performance characteristics of different pond designs in terms of sediment removal and its expected lifetime in providing this function are generally lacking.

5.4.3 Sediment Quality and Nutrient/Contaminant Release

Bulk sediment quality in terms of concentrations of heavy metals (Pb, Cu, Zn, Cd, Ni) nutrients (P and N) and persistent organics (PCB's) from the surficial and deep sediments of each pond can be used to evaluate sediment quality. The degree of contamination is mainly a function of the nature and magnitude of contaminant sources in the upstream watershed. With the exception of a few studies (e.g., Rowney, 1987), data for SWM facilities are lacking.

To provide an indication of contaminant uptake and release of sediment-associated nutrients and contaminants from storm pond sediments, various studies involving sediment characterization and dynamics of release can be made to provide estimates of the release of heavy metals, dissolved phosphorus, and nitrogen concentrations over time. This, in turn, will be related to pond performance for water quality control. Such studies are traditional for lakes, but few have been reported for SWM facilities.

5.4.4 Environmental Effects of Sediment Removal

Sediment removal from older ponds may be required to restore sedimentation performance. But sediment removal may destroy fish and wildlife habitat (e.g., emergent aquatic plants). Thus, optimization of sediment removal and a natural wetland community is required.

A more vexing issue is the disposal of pond sediments. Due to the heavy metal, herbicide and pesticide levels found on pond sediments, some of them may be classified as hazardous substances dependent upon the levels and test protocols used (is a "leachable" parameter or the "bulk" concentration used to establish the classification of hazard). While conceptually the issues raised should be no different than those associated with the disturbance of in-place pollutants or dredging, the test protocol and standard for wet pond sediments have not been clearly established. Alternative approaches discussed range from U.S. Army Corps of Engineers - type protocols for marine and lake sediments to Decommissioning Guidelines and their associated protocols for clean-up of industrial, commercial and agricultural soil systems.

To avoid issues raised by off-site disposal (at landfills, or hazardous containment sites), the provision for land areas adjoining the ponds for the disposal of sediments is potentially the most effective one from a management point of view. To be considered, however, is whether the pond is in the flood plain; if so, disposal on adjoining valley lands may not be recommended if the site is erodable during flood flows.

5.5 Biological Characteristics

Biological characteristics of a storm pond include the richness of the aquatic community, the extent of littoral and floating aquatic vegetation, the species and numbers of fish present, and the numbers and types of birds, reptiles and macroinvertebrates. These biological community attributes are often correlated with such storm pond design features as bottom slope, depth, area, outlet structure type and location and age (e.g., Schueler, 1987). Certain physical features of each pond may either limit or encourage aquatic plant growth and wetland development. Important features include water depth, sediment consistency, and the degree of exposure to higher current velocities. Wetland areas within a pond may provide the physical structure and food chain base needed to encourage colonization by warmwater fish and waterfowl.

A well-defined treatise linking pond characteristics to the development of a high biological diversity was not found in the literature. However, a rapidly accumulating literature (e.g., Minnesota Report on Ponds as Wetlands, etc.) indicate that excellent habitat and plant communities are found in SWM facilities. These data are sufficient to define appropriate principles of management.

5.6 Recreation

SWM (wet) ponds may provide the opportunity for sailing, non-body contact recreation (Kayaking), swimming, and skating. Constant water levels of wet ponds provide ideal conditions for several activities. However, high coliform levels may preclude swimming and pose a health hazard to body contact recreation, unless disinfection is applied to water discharged to the pond, or on curtained off areas (e.g. Fanshaw Reservoir). Sailing opportunities may be limited by the small surface area and physical access.

The extent to which wet ponds can be used for multiple purposes is an issue which requires more systematic analysis. Clear answers which are usable on all wet ponds may not evolve, rather specific uses which limit the idea of multiple purposes to single or several purposes unique to a particular wet pond may be the approach what evolves.

5.7 Maintenance

Pond maintenance is a major concern to municipalities whose responsibility it becomes to manage storm ponds after construction. Typical maintenance activities required on a monthly to annual basis include cutting grass, weed control, repair of any fences, removal of detritus from overflow structures, and macrohabitat features. Less frequent activities include repair of overflow structures and sediment removal.

Maintenance is also a factor in stormwater system design. Two design alternatives include distributed ponds versus one centralized pond. "Distributed" ponds each serve 5-10 ha while "centralized" ponds, also called regional ponds serve 100 ha. Distributed ponds are easier to implement during construction because each development can construct their own pond. However, one centralized pond provides economies of scale and few maintenance problems in terms of numbers of ponds to be maintained.

5.8 Safety

Wet storm ponds present a drowning hazard to young children who may play nearby. Dry ponds which are dry between storm events may be hazardous only during the runoff period. Deep wet ponds with steeply sloping grades may present a constant hazard, and may require access restrictions. The bottom grade and maximum flow velocity occurring in a storm pond in general are design features that affect the degree of hazard presented by storm ponds.

In cold water climates such as the Don River area, recreation skating occurs on wet ponds such as Mill Pond, Richmond Hill. This may pose a safety hazard whose legal responsibility has not been researched in this study. The normal storm water literature does not address such safety issues as skating hazards because only the northern part of North America and Europe have such possibilities.

Techniques to minimize safety concerns include the following. A chain-link fence prevents access, but is not desireable where environmental and social amenitities are a focus of the facility. Rather shallow bottom slopes onshore-offshore, and plantings of emergent vegetation such as cat tails to discourage wading into the pond are two techniques which have been successful in preventing drowning. Techniques for controlling recreational skating hazards have been successfully developed for Mill Pond in Richmond Hill and other ponds; it would be useful to systematize this information into pamphlets for distribution upon request.

5.9 Conflicts Among Objectives

Various conflicts arise among objectives for storm pond design, such as the following:

- very large and deep ponds may require fencing to prevent access by children;
- recreation, aesthetic considerations and wildlife habitat would suggest a different design is optimal;
- cost considerations require a minimal land area for pond construction while development of wetland habitat may require shallower slopes and larger surface areas to achieve the same storage;
- accumulation of metal in sediments for water quality purposes may lead to impacts on wildlife or fish;
- on-line ponds and their dams may prevent fish migration; and
- maintenance considerations favour one centralized pond while construction logistics and cost-sharing arrangements favour many smaller ponds.

Some of these conflicts have been examined previously in the TAWMS study. Some can be examined by modelling procedures; others require the establishment of priorities because multi-objectives may be impossible. One particular water quality conflict of concern is that ponds may remove contaminants during events, but pollute under low flow conditions by releasing contaminants from sediments. In certain cases, this could cause greater harm to utilization of the watercourse. Conflict between water quality and water quantity objectives have been characterized to some degree in the literature but not in a comprehensive fashion.

An evaluation of SWM ponds is needed to further develop the objectives of this study. The evaluation would:

i) describe the results of performance rankings in the categories of hydraulic control, water quality control, sediment removal, and provision of fish and wildlife habitat;

ii) clearly depict, document and rank these categories to the extent possible;

iii) prepare a framework for selection of desirable storm pond performance attributes to serve as a guide in the informed selection of designs for specific storm pond application; and

iv) develop a conceptual overview of water quality, quantity, biological, cost and safety conflicts for various classes of storm pond design and a description of the limits of resolving these conflicts will be included.

As well, hypotheses on design and performance would be developed, and the implications for environmental surveillance data, and more intensive studies would be detailed. For example, implied effects of ponds on water quality may require an extensive series of measurements over a wide range of conditions before firm conclusions can be made.

5.10 Overview of SWM Ponds In Place in North America

Despite the uncertainties associated with SWM ponds and requirements for further work to evaluate them, sufficient field and other work has been done to validate the following points:

- SWM ponds provide water quality and water quantity control and protection from erosion;
- SWM ponds have been constructed and successfully operated for several years; and
- SWM ponds provide environmental and social amenities.

An overview of these facilities has been given in several studies documented in the literature. A brief summary is now presented of two studies: (i) a local study, and (ii)

Washington, D.C. study. In one local study, an overview of 15 SWM facilities was presented for the Rouge River Management Study in terms of:

- Control structure,
- Design basis for water quantity control,
- Downstream erosion control benefit,
- Probable degree of water quality control for downstream river,
- Apparent internal water quality problems,
- Degree of surface level fluctuations,
- Littoral habitat,
- Presence of fish,
- Presence of marsh habitat,
- Presence of wildlife,
- Recreational swimming possibilities,
- Recreational skating possibilities,
- Recreational soccer possibilities,
- Internal erosion problems,
- grass cutting requirements,
- culvert cleaning requirements,
- maintenance requirements for sediment removal,
- external walkways/picnic areas,
- probable downstream temperature,
- possible nuisance conditions,
- cost of construction (generally unknown),
- safety issues (e.g., drowning potential), and
- general assessment.

These assessments should be extended to conduct similar assessments for SWM ponds presently in the Don River. This would provide a perspective on the magnitude, type and diversity of facilities presently in the Don River Watershed. A qualitative inspection of existing facilities suggests that there are a large number of ponds in the Don River which provide water quality and/or water quantity control as well as environmental and social amenities. A characterization of existing facilities would support the point that installation of wet ponds or equivalent is not a new strategy for water quality control in the Don River but rather an enhancement of strategies already in place.

In a second study (Schueler, 1987), an overall assessment of the:

i) water quality benefits,
ii) water quantity benefits, and
iii) environmental and amenities

provided by various pond designs has been prepared and summarized into a matrix format. The effectiveness for water quality purposes was given above in Figure 4.2 and discussed in Section 5.3. Projected benefits for water quantity control and environmental concerns are now assessed.

The effectiveness for water quantity and erosion control of the eight different BMP's are summarized in Figure 5.2. Overall the two types of wet ponds provide a higher degree of peak control than do such BMP's as grassed swales and filter strips. However, they provide little benefit for volume control unless they are designed to have significant infiltration abilities. Ponds provide significantly more benefits for erosion control than do vegetated BMP's such as swales.

These BMP's provide a spectrum of environmental and community amenities (Figure 5.3) for the following categories:

- low flow augmentation,
- streambank erosion control,
- aquatic habitat creation,
- wildlife habitat creation,
- temperature effects,
- landscape enhancement,
- recreational benefits,
- hazard reduction,
- aesthetics, and
- community acceptance.

Amenities of the eight designs are indicated in Figure 5.3 as follows: "a solid dot indicates that there is a strong potential for a BMP to provide the amenity; an open dot indicates the BMP has little or no potential; and a half dot suggests that a BMP might

FIGURE 5.2: COMPARATIVE STORMWATER BENEFITS PROVIDED BY URBAN BMPs

BMP	PEAK DISCHARGE CONTROL					
	2 YEAR STORM	10 YEAR STORM	100 YEAR STORM	VOLUME CONTROL	GROUNDWATER RECHARGE	STREAMBANK EROSION CONTROL
EXTENDED DETENTION						
DRY	●	●	●	○	○	●
DRY w/ MARSH	●	●	●	◑	○	●
WET	●	●	●	○	○	●
WET POND	●	●	●	◑	○	○
INFILTRATION TRENCH						
FULL EXFILTRATION	●	◑	○	●	●	●
PARTIAL EXFILTRATION	●	●	○	●	●	●
WATER QUALITY TRENCH	○	○	○	●	●	●
INFILTRATION BASIN						
FULL EXFILTRATION	●	◑	○	●	●	●
INFILTRATION/DETENTION	●	●	●	●	●	◑
OFF-LINE BASIN	○	○	○	●	●	◑
POROUS PAVEMENT						
FULL EXFILTRATION	●	◑	○	●	●	●
PARTIAL EXFILTRATION	●	●	◑	●	●	◑
WATER QUALITY	○	○	○	●	●	◑
WATER QUALITY INLET	○	○	○	○	○	○
GRASSED SWALE	◑	○	○	◑	◑	○
FILTER STRIP	◑	○	○	◑	◑	○

○ SELDOM OR NEVER PROVIDED
◑ SOMETIMES PROVIDED w/ CAREFUL DESIGN
● USUALLY PROVIDED

FIGURE 5.3: ENVIRONMENTAL AND COMMUNITY AMENITIES PROVIDED BY BMPs

BMP	LOW FLOW MAINTENANCE	STREAMBANK EROSION CONTROL	AQUATIC HABITAT CREATION	WILDLIFE HABITAT CREATION	NO THERMAL ENHANCEMENT	LANDSCAPE ENHANCEMENT	RECREATIONAL BENEFITS	HAZARD REDUCTION	AESTHETICS	COMMUNITY ACCEPTANCE
DRY EXTENDED DETENTION	○	●	◑	●	●	◑	◑	◑	◑	◑
EXTENDED DETENTION w/ MARSH	○	●	●	●	○	◑	○	◑	◑	◑
WET EXTENDED DETENTION	○	●	●	●	○	●	●	◑	◑	●
WET POND	○	○	●	●	○	●	●	◑	◑	●
INFILTRATION TRENCH	●	◑	○	○	●	○	○	●	○	●
INFILTRATION BASIN	●	◑	○	●	●	◑	◑	●	○	◑
POROUS PAVEMENT	●	◑	○	○	●	○	○	●	○	●
WATER QUALITY INLET	○	○	○	○	●	○	○	●	○	●
GRASSED SWALE	◑	○	○	◑	●	◑	○	●	◑	●
FILTER STRIP	◑	○	○	●	●	◑	○	●	◑	●
SHALLOW MARSH	○	○	●	●	○	◑	○	◑	◑	◑

○ SELDOM PROVIDED

◑ SOMETIMES PROVIDED (w/ Design Modifications)

● USUALLY PROVIDED

provide the amenity with some design modifications or as a result of unusual site conditions. The first five headings in Figure 5.3 refer to amenities related to the improvement of the natural environment, while the last five headings pertain to amenities which are provided to the adjacent community". The assessment of amenities are based "on opinion surveys and less formal surveys of complaints to public works officials", despite widely divergent opinions held on their values.

These charts provide a ready base of information for examining these facilities for purposes of Environmental Assessment. They are particularly useful for screening purposes in discussing alternatives, but also sufficiently quantitative to be used for preliminary impact assessment purposes.

5.11 Alternate Designs for Wet Ponds in the Don River Watershed

The installation of wet ponds has been accepted or rejected by various jurisdictions in the Toronto area based upon community and social amenities, effectiveness and maintenance requirements. Irrespective of their problems, several communities are now activity converting dry SWM ponds to wet ponds. The success of conversion has depended to a substantial degree upon providing landscape, aesthetic, and biological (fish, wildlife) values in the conversion.

Examples of two types of wet ponds are now presented for Extended Wet Ponds and Wet Ponds.

A schematic of a wet pond is given in Figure 5.4. As Schueler (1987) notes:

"Wet ponds, also known as retention ponds, are an extremely effective water quality BMP. If properly sized and maintained, wet ponds can achieve a high removal rate of sediment, BOD, organic nutrients and trace metals. Biological processes within the pond also remove soluble nutrients (nitrate and ortho-phosphorus) that contribute to nutrient enrichment (eutrophication). Wet ponds are most cost-effective in larger, more intensively developed sites. Positive impacts of wet ponds include: creation of local wildlife habitat, higher property values, recreation, and landscape amenities. Negative impacts include: possible upstream and downstream habitat degradation, potential safety hazards, occasional nuisance problems (e.g., odour, algae, and debris), and the eventual need for costly sediment removal."

A schematic of an extended wet pond (extended dry pond) is given in Figure 5.5. These ponds are created by creating a permanent wet pool in an existing dry pond, creating additional flood water storage in an existing wet pond, or constructing a new pond.

As Schueler (1987) notes:

"extending the detention time of dry or wet ponds is an effective, low cost means of removing particulate pollutants and controlling increases in downstream bank erosion. Extended detention ponds significantly reduce the frequency of occurrence of erosive floods downstream, depending on the quantity of stormwater detained and the time over which it is released. If stormwater is detained for 24 hours or more, as much as 90% removal of particulate pollutants is possible. However, extended detention only slightly reduces levels of soluble phosphorus and nitrogen found in urban runoff. Removal of these pollutants can be enhanced if the normally inundated area of the pond is managed as a shallow marsh or a permanent pool."

FIGURE 5.4: SCHEMATIC OF A WET POND

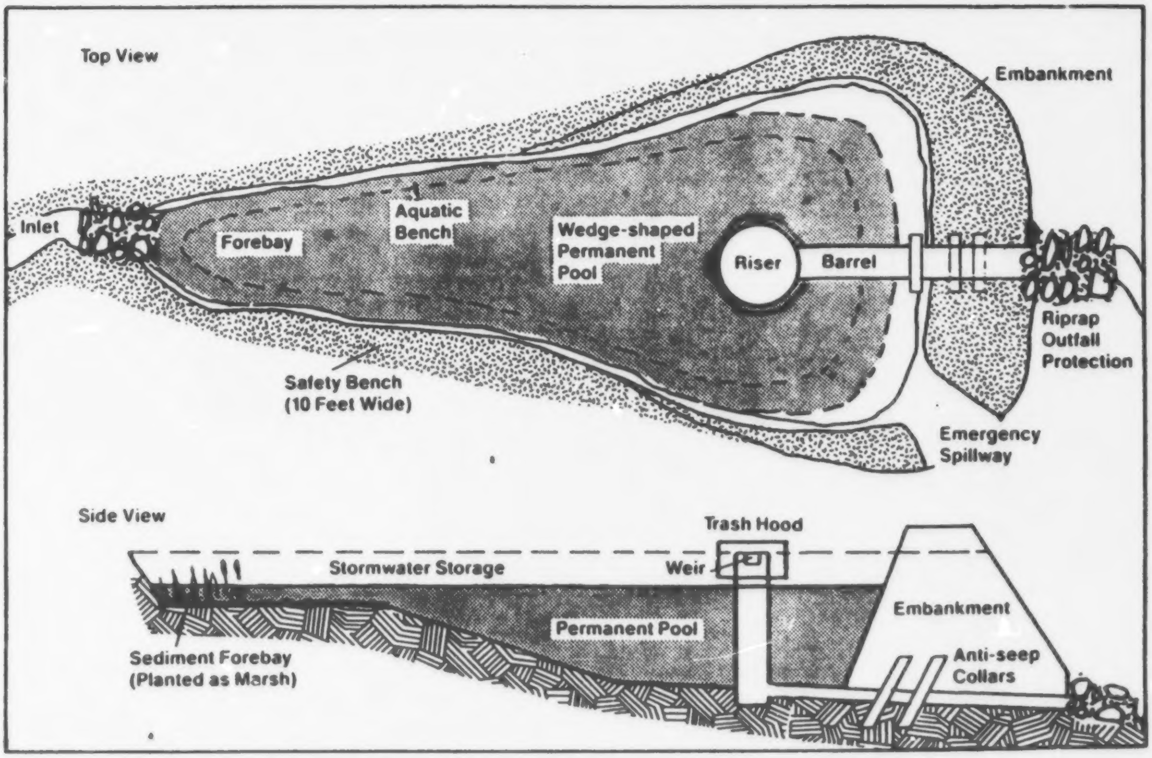
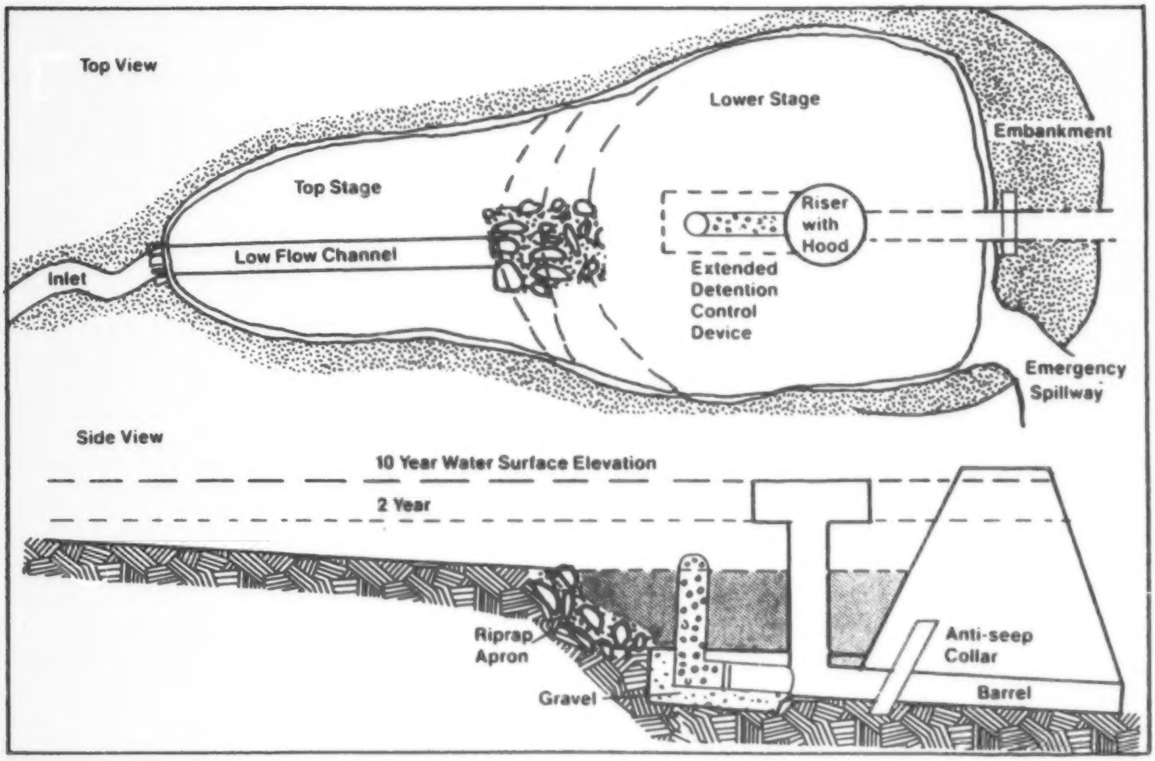

Top View
Embankment
Inlet
Forebay
Aquatic Bench
Wedge-shaped Permanent Pool
Riser
Barrel
Riprap Outfall Protection
Safety Bench (10 Feet Wide)
Emergency Spillway
Side View
Trash Hood
Stormwater Storage
Weir
Embankment
Permanent Pool
Anti-seep Collars
Sediment Forebay (Planted as Marsh)

FIGURE 5.5: SCHEMATIC OF A DRY EXTENDED DETENTION POND


Top View
Lower Stage
Embankment
Top Stage
Riser with Hood
Low Flow Channel
Inlet
Extended Detention Control Device
Emergency Spillway
Side View
10 Year Water Surface Elevation
2 Year
Riprap Apron
Anti-seep Collar
Gravel
Barrel

6.0 DATA USED FOR ESTIMATING COSTS OF THE DON RIVER STRATEGY

Cost estimates for the Don River Strategy are presented in the Summary Report. They are based upon data presented in this section. A detailed data base from which cost estimates for several programs are extrapolated in this section, are presented in Appendix C.

6.1 Remedial Programs Currently Inplace

A variety of programs are underway aimed at controlling pollutant discharges from urban sewer systems and water pollution control plants. The remedial programs under way were instituted through normal municipal practices, Conservation Authority Programs or through one of four OMQF programs:

- TAWMS: Toronto Area Watershed Management Strategy
- WWQIP: Waterfront Water Quality Improvement Program,
- MISA: Municipal-Industrial Strategey for Abatement, and
- Lifelines Programme (basically, an Infrastructure Rehabilitation Program)

Programs are in place to address the following problems (Anon, 1988).

1. Sewer Systems

    i) Dry Weather Discharge

    ii) Cross Connections
        - Residential
        - Industrial

    iii) Spills

    iv) Industrial Practices

    v) Residential Practices (personal ecology)

vi) Infrastructure

vii) Wet Weather Discharges - being addressed through the following:
  - wet weather discharges
  - pollution abatement programs
  - pilot programs

viii) Combined Sewer Overflows - being addressed through the following:
  - sewer separation
  - inlet control and infrastructure
  - storage and treatment

2. Water Pollution Control Plants

i) Effluent Control - being addressed through:
  - MISA
  - O&M audits
  - upgrading treatment efficiency

ii) Source Control - being addressed through:
  - model sewer use bylaw
  - MISA sewer use control program

iii) Sewer WPCP System Improvements - being addressed through:
  - sewer rehabilitation
  - increased WPCP capacity

6.2 Cost Estimates

These above programs all impact water quality in the Don River to varying degrees. Cost estimates for the following programs and control methods are now presented in this supporting document.

i) Cross-Connections
ii) Spills Program

iii) Infrastructure Program - Capital Cost
- O&M
- SIMS Studies

iv) Bylaws Pet Control
v) Bylaws Plumbing Inspection
vi) Bylaws Sewer Use
vii) Catch Basin Cleaning
viii) Hazardous Waste
ix) Aesthetic Clean-Up
x) Infiltration Control
xi) SWM Ponds
xii) MISA Auditing

Cost estimates for all the different programs (except SWM ponds) are given in Tables 6.1 to 6.3. The cost estimates are given by program for each municipality in Table 6.1 and synthesized into Table 6.3. The summary estimates are for the Don River watershed based upon apportioning the cost estimates developed for each municipality in the RAP study (Anderson, R.V., 1989) to their land area in the Don River Watershed. The land areas within the Don River watershed were based upon data from Canviro (1986; see Table 6.4) and a check of the Canviro data by planimetry of Figure 1 from the Summary Report. MISA cost estimates given in the Appendix were apportioned similarly and synthesized into Table 6.2.

Cost estimates for SWM facilities, disinfection, and CSO control were based upon MOE (1986) and recent costing data. Cost estimates given in the Summary Report represent capital costs for facilities which could treat the average rainfall event or could treat a more severe event. These capital costs, and land costs are reprinted in this supporting document on a constant dollar, annual cost basis. The detailed calculations are given in Table 6.5.

A summary of the costs is given in Table 6.6, and used directly in the "Summary Report".

TABLE 6.2: PROJECTED COST OF MISA PROGRAM TO DON RIVER WATERSHED

Region	Capital Cost (Annual Basis)*	Annual Costs	Total Cost
Metro	160	2,000	2,200
York	7	88	95
			2,300

*Based upon 10 year amortization period

TABLE 6.3: SUMMARY OF ANNUAL COSTS OF REMEDIAL PROGRAMS IN DON RIVER WATERSHED

Program	Cost ($million/year)
Cross Connections	6.7
Spills	0.3
Infrastructure (Capital Cost)	34
Infrastructure (O&M)	17
Infrastrucutre (SIMS)	3.4
Bylaws - Pet Control	0.6
- Plumbing	0.1
- Sewer Use	0.7
Sewer Use Control - MISA	2.3
Catch Basin Cleaning	1.6
Hazardous Waste	0.1
Aesthetics Clean-Up	0.1
Infiltration Control	8.7
Total Excluding Infrastructure	21
Total Including Infrastructure	76

TABLE 6.4: POPULATION AND PERCENT OF AREA OF MUNICIPALITIES WITHIN THE DON RIVER WATERSHED AREA (after Canviro, 1986)

Municipality	Classification	Population	Estimated % of Area Within Watershed
East York	Borough	94,476	95
Markham	Town	12,290	15
North York	City	420,332	75
Richmond Hill	Town	9,622	25
Scarborough	City	43,598	10
Toronto	City	184,429	30
Vaughan	Town	11,045	30

* Values as of 1982 (Min. of Municipal Affairs, 1984).

Total Population = 776,000; average density 21.5 people per hectare.

TABLE 6.5: COST ESTIMATES FOR WET PONDS, DISINFECTION, AND CSO CONTROL

Cost estimates and average sizes are based, in part, on work carried out in TAWMS "Feasibility Study and Costing of Proposed Pollution Control Measures in Humber Sewershed - Task 4".

Off-Line Wet Ponds - Existing Areas

average drainage area = 120 ha
cost/m^3 = \$50 (construction)
cost/m^3 = \$60 (appertanences; i.e. road access, control structure, outfall constr.)
average depth = 2m
land requirement = 0.005 ha/ha (from NURP)
number of ponds = 200
land cost = 250,000/ha (averaged; based on floodplain, parkland, and residential land)

volumes: 5 mm rain = 1 mm runoff = 10 m^3/ha. (see Document 1)
10 mm rain = 2.8 mm runoff = 28
20 mm rain = 6 mm runoff = 60

Cost estimates/facility (20 mm event)

20 mm event

$$60\ \frac{m^3}{ha} \times \$110/m^3 \times 120\ ha = \$792,000 \times 200\ ponds = \$160,000,000$$

$$60\ \frac{m^3}{ha} \times \frac{1}{2\ m\ deep} = \frac{30\ m^2}{ha\ drainage\ area}$$

$$30\ \frac{m^2}{ha\ drain\ area} \times 120\ ha = 3,600\ m^2/facility$$

$$3{,}600\ \text{m}^2 \times \frac{\text{ha}}{10{,}000\ \text{m}^2} \times \frac{\underline{\$250{,}000}}{\text{ha}} = \$90{,}000/\text{pond}$$

x 200 pond = $18,000,000
x 3 to account for access/grass, buffer zone, etc. = $54,000,000

Total = 160 + 54 = $214 mill; use $250 mill

Disinfection

Assumptions: U-V treatment

Design Standards

5 mm event - 1 mm runoff = 0.001 m/day x 120 ha/facility = 1,200 m^3/day/facility
10 mm event - 2.8 mm runoff = 0.001 m/day x 120 ha/facility = 3,360 m^3/day/facility
20 mm event - 6.0 mm runoff = 0,001 m/day x 120 ha/facility = 7,200 m^3/day/facility

Capital Costs - hydro, service building, appertanences (based upon article: "Disinfection of Low Quality Wastewaters by Ultraviolet Light Irridation". These values are more up to date than those given previously in "Feasibility Study and Costing of Proposed Pollution Control Measures in Humber Sewershed - Task 5" which gave the following cost estimates:

Construction Cost	$200,000/cms
U-V Light Costs	$150,000/cms
Total	$350,000/cms

Capital Cost

5 mm event= $200,000/facility or $40 million (based on 200 facilities)
10 mm event = $250,000/facility or $50 million
20 mm event = $300,000/facility or $60 million
Operation and Maintenance Cost/Year

5 mm event = $15,000/facility or $3 million
10 mm event = $20,000/facility or $4 million
20 mm event - $30,000/facility or $6 million

Total Annual Cost		Total Amortized Cost	
5 mm event =	$5.4 million	5 mm event =	$ 90 million
10 mm event =	$7.0 million	10 mm event =	$120 million
20 mm event =	$9.6 million	20 mm event =	$180 million

Combined Sewer Overvlow - Treatment & Storage

Costs based on "Feasbility Study and Costing of Proposed Pollution Control Measure in Humber Sewershed - Task 1" and "Humber Sanitary Trunk Sewer System and Treatment Plant Study".

Based on 1 overflow event/year

storage volume = 150,000 m^3
storage cost = $\$300/m^3$
Total = $45,000,000*

* includes capital, operation and maintenance costs.
treatment costs - assumes secondary treatment required

Cost = $2.5 million/MGD of capacity (Humber Sanitary Trunk Sewer System & Treatment Plant Study)

volume 3 37 MGD
total = $93 million
use $100 million

TABLE 6.6: SUMMARY OF RELATIVE COSTS (DOLLARS) ASSOCIATED WITH DIFFERENT CONTROL OPTIONS AND REMEDIAL PROGRAMS

Option/Program	Cost ($million/year)
Cross-Connections	6.7
Spills	0.3
Bylaws	1.4
Other Programs	1.8
Sewer Use and MISA	2.3
Infrastructure	54
Infiltration Control	8.7
Off-Line Ponds	6-30
Flow Reduction Through Redevelopment+	12-24
Land*+	20-100

* Assumes 1% of watershed required for treatment facilities.

+ Cost of aquisition amortized over 50 years for land; over 50 years for infrastructure replacement, and 10 years for off-line ponds and flow reduction.

7.0 COMMENTS ON AN IMPLEMENTATION PLAN FOR THE DON RIVER SYSTEM

Implementation, Maintenance and Safety and Auditing play a key role in achieving the effectiveness of control options outlined previously. These aspects of a water quality management plan should be developed in the future. A summary of implementation considerations for the Humber River is given in Table 7.1.

A plan for implementation of the Don River Strategy needs to be developed together with targets for achievement and auditing its success, after evaluation of maintenance and safety aspects. Such a plan is beyond the scope of this study. However, implementation considerations were used in selecting the control options and in developing short and long-term implementation activities given in the summary report and in the fisheries study (Supporting Document 1).

Control options and the ultimate strategy given in the summary report were selected because they have been constructed or implemented in other areas and have proven to be effective. However, feasibility factors and considerations such as public and municipal acceptance, and ease of implementation were not evaluated.

The strategy was divided into three phases, based in part upon whether or not the measures were readily implemented. The first two phases attempt to include those mitigating options which are readily implementable and quite cost-effective. The third phase includes those measures which are required to achieve significant water quality improvements over the long term but which are more costly and less readily implementable. The suggested strategy also reflects the implicit philosophy that treatment of all sources by structural and non-structural methods will ultimately be required to attain the beneficial end uses of a quality fishery contained in a non-toxic, swimmable water.

The following measures are given in the Summary Report for the immediate period of time. They are presented here in brief phrases and in full language in the Summary Report.

The measures are divided into three phases, as follows:

(i) Immediate Actions (1989-1990)
(ii) Phase 1 (5-10 Year Timeframe)
(iii) Long-Term (10-50 Year Timeframe)

7.1 Immediate Actions (1989-1990)

These ("immediate action") measures were included in the immediate phase because they were readily implementable (Measures 1, 2, 3, 13), needed for new developments (Measures 4, 5, 11) or represented information for subsequent phases (Measures 6, 7, 8, 9, 10, 12).

The short-form description of the measures is as follows:

Measure 1:

Aesthetic improvements (stream cleanup; marsh grass for fish habitat; and signage).

Measure 2:

Demonstration projects (natural channel design; urban fishing; disinfection or extended storage of a wet pond to achieve swimming objectives).

Measure 3:

Develop a manual based upon wet pond demonstration projects from other watersheds.

Measure 4:

Off-line, wet ponds, Urban Best Management Practices, provision of bacterial control in all new developments.

Measure 5:

Flow reduction in new developments.

TABLE 7.1: IMPLEMENTATION CONSIDERATIONS DEVELOPED FOR HUMBER RIVER

Recommendations	Implement. Environ.		Possible Implementor					Possible Funding					Approval Mechanism	Phase	Comments
	Existing	Needs Dev.	Local Mun.	Metro	Cons. Author.	Prov.	Fed.	Local Mun.	Metro	Cons. Author.	Prov.	Fed.			
1. Enhanced catchbasin cleaning	X		X	X				X	X		X		Municipal budgeting	I	Can be implemented immediately
2. Reduction of CSO (installation operation & maintenance of storage tanks and WPCP treatment)	X	X	X					X	X		X		LRIA(possibly OWRA, EA) Municipal budgeting	I	Requires funding formula change and province. MTC subsidize cur
3. DWF bacteria reduction - (a) trace/Elim	X		X					X			X		Existing by-laws	I	Underway
- (b) collection	X	X	X	X				X	X		X		LRIA (possibly OWRA/EA)	II	Depends on success of 3a
- (c) disinfection - pilot project		X				X	X				X	X	OWRA (possibly LRIA/EA)	I	Can be implemented immediately
- full scale implementation		X	X	X				X	X		X		"	II	Depends on success of 3a and pi
4. Curtail legal and illicit continuous discharges (prevent, eliminate & review bylaws)	X	X	X	X		X	X	X	X		X	X	Modify bylaw	I	Partially Ongoing. Initiate exp
5. Industrial ponds (installation, operation & maintenance) - pilot project		X				X					X		LRIA/OWRA/EA	I	Can be implemented immediately
- full scale implementation		X	X					X	X		X		" "	II	Depends on success of pilot pro
6. Residential ponds (" " ")		X	X	X				X	X		X		LRIA/OWRA/EA	II	Depends on success of rec 4 pil
7. Prevent intermittent dumping (education, identification, data base, contingency and elimination)	X	X	X	X		X	X	X	X		X	X	Existing bylaw	I	Can be implemented immediately programs
8. HC handling and disposal (develop and implement programs)	X	X	X	X	X	X	X	X	X		X	X		I	Partially Ongoing. Initiate exp MOE has model programs
9. Dog bylaws, litter control, snow disposal and emission controls (education/enforcement enhancement)	X	X	X	X	X	X	X	X	X	X	X	X	Existing Programs	I	Partially Ongoing. Initiate exp
10. Basement flooding reduction (use of storage tanks Vs sewer separation	X		X					X	X		X		OWRA	I	Can be implemented immediately. formula changes similar to rec
11. Enhanced erosion control (redevelopment/new development, modern stormwater Management Practices)	X	X	X		X	X		X	X	X	X		Planning Act, LRIA	I	Ongoing, enhancement depends or guideline development
12. Enhanced upper Humber controls	X	X	X York and Peel Regions		X	X		X York and Peel Regions		X	X		Existing programs and studies	I	Possible future federal involv reductions. OMAF OSCEPAP progr
13. Enhanced water quality monitoring	X		X	X	X	X		X	X	X	X	X	None required	I	Can be implemented immediately
14. Enhanced fishery habitat - pilot project	X	X				X					X	X		I	MNR fisheries management plan
- full scale implementation	X	X			X	X				X	X			II	Depends on success of pilot pr

MOE = Ministry of the Environment
MNR = Ministry of Natural Resources
MTC = Ministry of Transportation and Communication

LRIA = Lakes and Rivers Improvement Act
OMAF OSCEPAP = Ontario Soil Conservation and Environme
Assistance Program of the Ontario Minis
Agriculture and Food.
OWRA = Ontario Water Resources Act
EA = Environmental Assessment

Measure 6:

Adoption, in an appropriate manner, of interim stormwater quality guidelines by municipalities.

Measure 7:

Documentation of present stormwater management facilities in the Don River watershed.

Measure 8:

Establish sites for control of bacterial discharges.

Measure 9:

Develop useful criteria for design and approval of wet ponds.

Measure 10:

Conduct additional studies necessary to allow implementation of study's recommendations.

Measure 11:

Erosion and sediment control during construction.

Measure 12:

Food supply from intermittent, order 1 headwater streams to downstream fishery.

Measure 13:

Implement vegetated BMPs in publically-owned, valley lands.

7.2 Phase 1 (5-10 Year Timeframe)

These measures (5-10 year timeframe) were included in this phase because they represented a continuation of measures not completed in the immediate phase (Measures 1, 2, 5, 6, 10), because they are measures which require some lead time to implement (Measures 3, 4, 7, 8, 9, 14, 16, 17, 18) or because they represent additional technical studies or further long-range planning (Measures 11, 12, 13, 15).

The short-form description of the measures is as follows:

Measure 1:

Construct off-line, wet ponds and urban BMPs and audit their performance in new developments.

Measure 2:

Construct off-line ponds within existing urban areas.

Measure 3:

Fish habitat restoration.

Measure 4:

Control usage of fertilizer, solvents, residential and agricultural herbicides, pesticides, and fungicides.

Measure 5:

Audit remedial programs already in existence.

Measure 6:

Existing cross-connections detection programs.

Measure 7:

Flow reduction in redeveloping commercial/industrial areas.

Measure 8:

Source control programs.

Measure 9:

Comprehensive spills control programs.

Measure 10:

Enforcement of erosion and sedimentation control guidelines during construction.

Measure 11:

Additional information required.

Measure 12:

Possible need for physical-chemical treatment technologies.

Measure 13:

Comprehensive basin management planning.

Measure 14:

Program for assisting the municipalities.

Measure 15:

Demonstrate achievement of the water quality strategy.

Measure 16:

Education programs for controlling household chemicals.

Measure 17:

Watershed maps (by region or city) to assist plan implementation.

Measure 18:

Design a more natural habitat into rechannelization projects.

7.3 Phase 2 (Long-Term) - (i.e., 10-50 Year Timeframe)

Measures identified for the long-term phase are included because they represent a continuation of measures not previously completed (Measures 1, 2, 3); the application of newer technologies (Measures 5, 6) or technologies not previously accepted by various parties (e.g., Measure 4); and a long-term auditing and program update feedback system (Measure 7).

The short-form description of the measures is as follows:

Measure 1:

Continue implementing earlier control efforts.

Measure 2:

Off-line ponds in remaining urban areas.

Measure 3:

Flow reduction alternatives continued to be implemented.

Measure 4:

Control devices for floatables, oil films, spills and debris.

Measure 5:

Bacterial quality in existing reservoirs (e.g., G. Ross Lord Reservoir) and new ponds.

Measure 6:

Evaluate levels of protection obtained and the need for newer technologies.

Measure 7:

Audit, replace and update remedial programs every five years.

Implementation aspects are also implicit in the definition of short-term and long-term objectives given in Supporting Document 2 for water quality aspects related to public health, property protection, aesthetics, drinking water, riparian vegetation and canopy, and health of the fishery and ecosystem. They are as follows:

Public Health and Aesthetics

Short-Term Objectives	Long-Term Objectives
1. **Contact Non-Contact Recreation**	
a) Assess achievability of swimming goal over the long-term	a) Achieve objective for incidental contact
b) Assess achievability of a goal for incidental contact over the short-term	b) Achieve objectives for swimming in selected ponds and reservoirs

Short-Term Objectives	Long-Term Objectives
c) Establish technical objectives for a goal of incidental contact with water	c) Possibly achieve swimming objective in all river waters, most of the time
d) Implement necessary controls for "no lumps/waste flows" etc.	
e) Reduce bacterial loadings from priority sources	
f) Achieve contact recreation water quality objective (100 FC/100 mL) in prime swimming areas (e.g., a few ponds/ reservoirs) some of the time	
2. Drinking Water	
a) Survey all present well water supplies to individual homes to ensure that they achieve drinking water objectives	a) Evaluate need for changing objectives for incidental ingestion of surface water
b) Establish water quality objectives for incidental ingestion of surface waters in the Don River Watershed	b) Achieve water quality objectives for incidental ingestion, most of the time
c) Achieve water quality objective for incidental ingestion in areas prone to such occurrences	c) Evaluate need and/or feasibility of drinking water objective for water from reservoirs, in light of achievement of objectives related to bacterial control

	Short-Term Objectives		Long-Term Objectives
3.	**Fish Consumption**		
a)	Assess transmittable diseases; control all sources	a)	Complete the assessment and determination of appropriate objectives, initiated for the short-term
b)	Assess chemical burden in fish from metals, radionuclides and SOC's	b)	Change chemical and biological parameters for assessing long-term objective as new chemical data, new contaminants and/or new concerns are identified
c)	Differentiate fish burdens as to source of origin (implace pollutants, stormwater, sewage, agricultural runoff, other human activities in the watershed, and atmospheric inputs)	c)	Attain long-term objectives by appropriate means
d)	Assess contaminant burden in sediments of depositional environment and determine the geochemical		
e)	Establish criteria for long term objectives		
f)	Clean up (by dredging or other techniques), hot spots which cause significant contaminant bioaccumulation in fish or in the food chain		
4.0	**Aesthetics**		
a)	Reduce total P loads to reduce periphyton and other abnormal algal growths	a)	Attain a balanced ecosystem which generates natural odours even though they are unpleasant as a result of decay processes
b)	Assess causes of unpleasant odours; realize that decay processes are the causes of some unpleasant odours but are an essential part of the ecosystem		

Short-Term Objectives	Long-Term Objectives
	b) Return the river to a mesotrophic state rather than the present hypereutrohpic state
c) Reduce impacts of vegetation to river where organic matter is beyond the requirements of fish and a balanced ecosystem	c) Eliminate all sources of CSOs and industrial wastes
d) Reduce suspended solids/turbidity inputs by vegetating banks and achieving some reduction in suspended solids	d) Control all spills
e) Control some CSO discharges (either on frequency or volume basis) and separate contaminated industrial discharges from storm sewer system	e) Control all stormwater discharges
f) Control turbidity discharges from all new developments and redeveloped areas	
Public Safety	
5. Erosion and Flood Control	
a) Vegetate lands, obtain setbacks and conduct other passive measures to minimize erosion at active sites	a) Minimize erosion
b) Continue to assess which erosion scars are natural and hence those for which human intervention will not be overly successful	b) Change erosion control policies, as scientific/geomorphological understanding of the causes of erosion increases

Short-Term Objectives	Long-Term Objectives
c) Change channelization construction designs to take account of fisheries objectives	
d) Establish policies to increase infiltration of rain water where soils conditions permit, as redevelopment occurs	
e) Implement erosion control measures in small catchments	
Fisheries and Riparian Habitats	
6. River Beds as Fish Habitat	
a) Replace concrete lined channels as opportunities arise	a) Replace all past concrete-lined, channelized river beds with stable structures which provide fish habitat, bottom vegetation, and hydraulic transport capabilities
b) Reduce algal growth using objectives laid out above	b) Achieve nutrient control objectives
c) Implement CSO/industrial/stormwater controls to improve habitat	c) Complete control of CSO, industrial and stormwater discharge
d) Improve canopy cover	
7. Angling	
a) Establish smallmouth bass and other appropriate species as an indicator of a quality guild of warmwater species of fish	a) Develop balanced food web for fish

Short-Term Objectives	Long-Term Objectives
	b) Carry out necessary habitat improvements
b) Assess long-term cold-water objective	
c) Complete indepth HSI evaluation initiated in this study	c) Control all contaminant inputs to level necessary
d) Establish fish management plan	d) Develop the balanced ecosystem required for a smallmouth bass guild, and possibly for a cold-water fish build
e) Maintain food sources transported from upper watershed to lower watershed for fish	
f) Reduce frequency of spills	e) Manage human fishing pressure
g) Reduce toxicity of river water	
h) Audit performance of plan using IBI	
i) Establish fishing pressure limits to sustain a fishery	
8. Enjoyment of Plants and Wildlife	
a) Assess public perception of requirements for enjoyment of a healthy riverine/valley environment	a) Assess changing attitudes and needs of the public
b) Establish a parameter for assessing enjoyment of the public	b) Audit the success of established plans
c) Initiate revegetation	

Short-Term Objectives

9. Wildlife and Waterfowl

a) Develop requirements for a balanced wildlife regime in an urban dominated valley system, taking account of existing core areas (e.g., Maple MNR lands, Science Centre, conservation lands)

b) Develop a plan

c) Initiate revegetation

d) Augment habitat in existing areas

e) Develop policing necessary to preserve and protect existing areas against vandalism etc.

Long-Term Objectives

a) Implement complete plan

b) Protection of habitat and wildlife/waterfowl against vandalism, illegal hunting and trapping

8.0 REFERENCES

Anderson, R.V. 1989. Documentation of Current Remedial Programs. Report prepared for Metro Toronto Remedial Action Plan, c/o Central Region, MOE, 14 Overlea Boulevard, Toronto, Ontario.

Anon. 1988. A Discussion of Existing Remedial Programs for Sewers and Water Pollution Control Plants (WPCP's). Discussion Paper.

Beak Consultants Limited (BEAK). 1986. Modelling the Fate of the Herbicide Atrazine in an Agricultural Watershed. Report for the Ontario Ministry of the Environment.

DiToro, D.M. and M.J. Small. 1979. Stormwater Interception and Storage. J. EED Proc. ASCE, Vol. 105 (EE 1).

Doe, K.G. and P.G. Wells. 1978. Aquatic Toxicity and Dispersing Effectiveness of Oil Spill Dispersants: Results of Canadian Oil Dispersant Testing Program (1973-1977) in Chemical Dispersants for the Control of Oil Spills. ASTM STP659 (LT McCarthy et al., ed). ASTM pp. 50-65.

Driscoll, E.D. 1986. Detention and retention controls for urban runoff, pp. 381-393. in: Urban Runoff Quality-Impact and Quality Enhancement Technology. B. Urbonas and L.A. Roesner (Eds.). Published by Am. Soc. Div. Engr.

Exxon. 1973. Tables of Useful Information. Exxon Publication Lab Text D400.

Environment Canada. 1984a. Benzene. ISBN-0-662-13181-9.

Environment Canada. 1984b. Toluene. ISBN-0-662-13204-1.

Hartigan, J.P. 1986. Regional BMP Master Plans, pp. 351-365. In: Urban Runoff Quality-Impact and Quality Enhancement Technology. B. Urbonas and L.A. Roesner (Eds.). Published by Am. Soc. Civ. Engr.

Hey, D.L. 1986. Lake Ellyn and urban stormwater treatment. In: Urban Stormwater Detention Facilities.

Huitved-Jacobsen et al. 1987. Urban Runoff Pollutant Removal in Wet Detention Ponds. Proc. Fourth International Conference on Urban Storm Drainage.

Huber, W.J., J.P. Heaney, S.J. Nix, R.C. Dickinson and D.J. Polmann. 1982. SWMM (Stormwater Management Model: User's Manual), Version (III). Report to U.S. Environmental Protection Agency, Municipal Environmental Research Laboratory, Cincinnati, Ohio, 45268.

Kronis. 1982.

Metropolitan Washington Council of Governments (MWCOG), 1987. Controlling Urban Runoff: A Practical Manual for Planning and Designing Urban BMP's. 170 pp. (Also listed as Schueler, 1987).

MOE. 1983. Humber River and Tributary Dry Weather Outfall Study. TAWMS Study Technical Report No. 1.

MOE. 1987b. Mimico Creek Dry Weather Outfall Survey. Tech. Report. No. 12.

MOE. 1987a. Don River Dry Weather Outfall Survey: TAWMS Technical Report No. 11.

MOE. 1986. TAWMS - Appendix A: Evaluation of Control Options.

Randall, C.W. et al. 1986. Urban runoff pollutant removal by sedimentation. *In:* Urban Stormwater Detention Facilities.

Rowney, A.C. and P.E. Wisner. 1984. QUALHYMO, User Manual Release 1.0. University of Ottawa, Ottawa, Canada.

Schueler. 1987. Controlling Urban Runoff: A Practical Manual for Planning and Design Urban BMP's. Metropolitan Washington Council of Governments. 179 pp.

Trotter, D.M. 1984. Scientific Criteria Document for Standards Development: Benzene and Substituted Benzenes in the Aquatic Environment. Report for Ministry of Environment.

Woodward-Clyde. 1986. Methodology for Analyses of Detention Basins for Control of Urban Runoff Quality. Report for U.S. Environmental Protection Agency, Washington, D.C.

APPENDIX 1

QUESTIONNAIRE DEVELOPED IN THIS STUDY FOR SPILLS EVALUATION

APPENDIX 1: Questions Sent to Each Municipality

Preamble

Definition of Spill. A spill is defined as the accidental or intentional release of a pollutant to urban areas in a pulse manner which will reach rivers through ditches, storm sewer systems, or groundwater systems.

Primary emphasis is placed in this study upon surface water pathways (ditches and storm sewers).

Spillage which is successfully intercepted by foam, dykes or other devices are to be included in the estimates of spillage.

We think that spills can be divided into the following categories:

- reported, unreported,
- accidental, intentional, and
- mobile source, fixed source.

Included in "intentional" would be dumping of cleaner fluid or solvents by householders into the storm system. "Accidental" would include upsets of tanker trucks, spillage around gasoline stations, and washing down of automobile leakage by home owners.

Questions

Given the above introduction, could you each reply to the following questions for urban areas?

1. Can you provide estimates of how many spills there are in your municipality? Can you:
   - give examples of size and type, and
   - characterize the percentage from fixed installations and the percentage from mobile sources

Please break the estimates down into:

1a) reported spills (i.e. originator reports the spill); and

1b) unreported spills (i.e. spills identified by anyone other than the originator). Note: unknown spills (i.e. those where evidence of the spill is noticed long after the fact or are thought probable, but without direct evidence) are covered under question 4).

2. Characterize the sources of contaminants in spills.

2a. Can you characterize the type of contaminants in each spill (e.g., gasoline, other petroleum products, oil and grease, pesticides, fertilizers, floor washings, coolants, mobile truck washings, mobile catering trucks, steam cleaners, and paint)?

Examples of the type of information being sought is summarized on:

i) Pg. 5.15 of "BEAK" Water Quality Study - Phase II - The Rouge River Watershed Urban Drainage Plan Study.

ii) Appendix A: Evaluation of Control Options - Humber River Water Quality Management Plan, 1986.

This information was given out at the October 3, 1988 meeting.

2b. Can you describe the original of the spill according to landuse type. Use the following categories:

a) old, industrial
b) new, industrial
c) residential
d) central business district
e) agricultural
f) transportation

3. Could each municipality update the summary of your spills given in the TAWMS summary (Appendix A, "Evaluation of Control Options ..."). For municipalities such as the Town of Vaughn and Markham or the Region of York, you will need to develop such a statement.

4. Can you qualitatively estimate the number of "unknown" spills (i.e., those which are neither reported nor are unreported in your jurisdiction, their source, and their constituents?

5. Summarize your perception of the most damaging type of spill problems in your jurisdiction (i.e., are they small; frequent unreported spills; major reported spills; from mobile or fixed installations).

6. What is your response system? Is protecting the receiving water a high or low priority within your spills program? What is the relative weight given to human safety in comparison to environmental concerns?

7. What is your involvement in clean-up procedures? What resources are available? Are stand-by crews used?

8. What type of management programs and/or modificiations to existing programs are needed to manage spills? Note: no written response is required here.

9. What types of control options are currently used to prevent or minimize spills reaching water courses? What control options are used to mitigate the impact upon receiving waters?

10. What new or alternative types of control options are required to control/mitigate spills? Note: no written response is required here.

11. Do you have any estimates of:

    a) costs of your present spill management system?
    b) cost of an optimum management system?
    c) costs of control options, either presently used or desirable for future usage?

    Estimates are requested, if no hard data are available. If possible, note costs in terms of engineering (works department) costs, and other municipal department costs (fire department costs, etc. for "costs of the present spill management system").

12. If you have a significant rural/agricultural sector within your jurisdiction, could you please attempt to answer the above 11 questions for the rural sector separately.

APPENDIX 2

SUMMARY OF RESPONSE TO SPILLS QUESTIONNAIRE DEVELOPED AND SENT OUT IN THIS STUDY

APPENDIX 2: RESPONSES RECEIVED TO QUESTIONNAIRE FROM THIS STUDY

QUESTION 1: CAN YOU PROVIDE ESTIMATES OF HOW MANY SPILLS THERE ARE IN YOUR MUNICIPALITY? CAN YOU:

- o give examples of size and type;
- o characterize the percentage from fixed installations and the percentage from mobile sources; and
- o break the estimates down into reported spills (i.e. originator reports the spill); and unreported spills (i.e. spills identified by anyone other than the originator).

Scarborough's Response

- Approximately 3 spills per week.
- Of all spills, 3% are reported; 75% are unreported, 22% are unknown.
- Type: 80% of spills are petroleum or petroleum based, 20% spills are other (non-petroleum) products.
- Size: 95% of spills are less than 5 gallons in volume, 5% of spills are very large in volume (e.g. 1,000 gal 12% sodium hypochlorite; 10,000 kg of parafin wax; 200 gal childrens finger paint).
- Location: 85% from mobile sources, 15% from fixed sources.

Toronto's Response

In 1988 a total of 6 spills occurred within the Don River Drainage Area.

- o 5 of these spills were reported,

- 4 were from fixed installations and 1 was from a mobile source,
- volume of spills ranged from 5 L to 2,000 L, the fixed sites being at the larger end of the scale,
- major portion of fixed site spills contained on site with only minor, if any, volumes entering the sewer system.
- 1 spill within the Don River Drainage was unreported in 1988, and
- quantity of source of spill unknown.

East York's Response

The Borough has not experienced a large spill in the recent past and very few spills have been reported to the Borough. Therefore, from our perspective, spills have not been a major problem.

We have crudely estimated there may be as many as 11,000 local minor spills per year within industries in the Borough. The volume of spilled materials is probably less than two litres per episode and the types could vary from solvents to process chemicals. It is also estimated that most of the spilled materials may be flushed down drains leading to the sanitary sewer system, and thus will not gain access to the local stream system.

Metro Toronto's Response

In 1987, Metropolitan Toronto Works Department received twelve (12) "reported spills" to the Don River Watershed.

- A detailed list is given in the "1987 Don River Watershed Spills Summary" in the main body.
- 83% of "reported spills' were from fixed installations, 17% from mobile sources.

Vaughan's Response

Approximately 25 spills per annum.

Re size and land use:

- 40% minor size, industrial source,
- 20% minor size, residential source,
- 10% minor size, transportation corridor source,
- 20% intermediate, industrial, and
- 10% intermediate, transportation corridor.
- 80% from fixed installations, and
- 20% from mobile sources.

Region of York's Response

1987-82 spills
1988-68 spills

- Originator reported 25% directly to Works Department.

- Many others handled directly by fire department or local municipality and not reported to Works Department of the Region.

- Size:
  - 25% less than 100 L
  - 75% GT 100 L
  - Very large - 5-10 spills/yr.

- Sources: 90% transportation; 10% fixed installations (coarse estimate).

Town of Richmond Hill's Response

- Number of Spills - 40 per year

- Example & Size - gasoline spillage, generally 5-20 gallons/spill
  - others - chemicals etc. - up to 25 gallons/spill

- Sources Fixed installation - about 252

- Reported spills - 95%, unreported spills - 5%

QUESTION 2: CHARACTERIZE THE SOURCES OF CONTAMINANTS IN SPILLS

2a. Can you characterize the type of contaminants in each spill (e.g., gasoline, other petroleum products, oil and grease, pesticides, fertilizers, floor washing, coolants, mobile truck washing, mobile catering trucks, steam cleaners, and paint)?

2b. Can you describe the original of the spill according to landuse type.

Scarborough Response

Percentage: gasoline 35%, petroleum products 25%, oil and grease 20%, pesticides and fertilizers 2%, floor washing 5%, coolants 1%, stream cleaners 10%, and paint 2%.

Origin According to Land Use

- old, industrial 35%
- new, industrial 25%
- residential 20%
- central business district 10%
- transportation 10%

40% in area north of 401 and west of McCowan, 40% in area south of Eglinton and west of Brimley, and 20% in area over remainder of city.

City of Toronto Response

- 4 of the reported 5 spills were either gasoline or fuel oil with volumes that ranged from 5 L to 600 L,

- the remaining spills was a rubber solvent compound of 2,000 L,

- 3 of the fixed installation spills occurred in an industrial area of the Lower Don River, and

- the remaining fixed installation spill occurred in an industrial area on a Don tributary north of Bloor.

East York Response

Based on the locations of industrial areas, the reaches of the Don River susceptible to spills are:

- the West Don River between Eglinton Avenue and Overlea Boulevard,
- the East Don River north of Northline Road, and
- Massey Creek immediately downstream of the Woodbine Bridge.

Metropolitan Toronto Response

- Detailed reply is given in main body.

Vaughan Response

Type of Contaminants:

Oil, grease, fuel, detergent, paint, cleaner, acid, resin, solvent, acetate-glue, chemicals.

Land Use Origins:

Region of York Response

a) Type of Contaminants

- Greater than 50% are petroleum and various forms of petroleum products.
- Remainder are a hodge podge of types.

b) Location of Fixed Sources

Old industrial	0
CBD/new industrial	50%
Residential	25%
Agricultural	25%

Location of Transportation Sources

- Along major corridors and urban areas.
- 30-40% in Markham area; 30-40% in Richmond Hill area.
- 40% of reported and unreported spills would occur in Don River Watershed.
- In Don River watershed, majority of spills occur along Hwy. #7 and major north-south corridors (e.g., 400, 404, Yonge Street, etc.)

Town of Richmond Hill's Response

- Sources of contaminants in spills - service station accidents (overflows), vehicle accidents
- Type of Contaminant - gasoline, fuel oil, photo-developing chemicals, acids and alkalies, transformer oils
- Origin of spill by land use
  - b) New, industrial - construction equipment
  - c) residential - vehicle leaks; use of paints drained into sewer laterals and catchbasins
  - d) CBD - service stations
  - f) Transportation - Highway Accidents

QUESTION 3: **COULD EACH MUNICIPALITY UPDATE THE SUMMARY OF YOUR SPILLS GIVEN IN TAWMS SUMMARY.**

(Update provided only by Metropolitan Toronto; attached).

QUESTION 4: **CAN YOU QUALITATIVELY ESTIMATE THE NUMBER OF "UNKNOWN" SPILLS**

(i.e., those which are neither reported nor are unreported in your jurisdiction, their source, and their constituents?

Scarborough Response

Approximately 1 per week, most frequent in spring and fall. They appear most often as oil films on the surface of watercourses.

City of Toronto Response

Unknown spills may be roughly related to the number of "odour" complaints received during the year. These numbers approximately 50 per year throughout the city, however, they are unconfirmed and there is generally insufficient information or evidence to trace and/or identify the source of odour.

East York Response

No estimates.

Metropolitan Toronto Response

Thirty-one (31) "unreported spills" complaint calls were received and investigated in 1987. "Detail of Spills" in the main body gives their source and constituents.

Town of Vaughan Response

Estimate of number of "unknown spills" not provided; the possible source of "unknown spills" was estimated as follows:

- fuel, oil, grease from mobile sources, 50%.
- detergent, paint, solvent, cleaner, oil from households 30%.
- chemicals, oil, grease from industrial sources 20%.

Region of York Response

An estimate of 100 per year.

Town of Richmond Hill Response

This response was influenced by the terminology "unknown spill". Response - No unknown spills are deliberate placement of paint thinners in household laterals and street catchbasins by residents - probably 75% of total.

QUESTION 5: SUMMARIZE YOUR PERCEPTION OF THE MOST DAMAGING TYPE OF SPILL PROBLEMS IN YOUR JURISDICTION

(i.e., are they small; frequent unreported spills; major reported spills; from mobile or fixed installations).

Scarborough Response

Unknown and unreported "quick" spills of petroleum (5 to 10 gallons) create a cumulative impact or watercourse.

City of Toronto Response

Potentially the most damaging spills are those from large fixed location spills that if they enter the sewer system would have a significant impact on the receiving waters. In 1988, this impact was minimal as most of these types of spills were contained on site.

East York Response

No reply.

Metropolitan Toronto Response

A major spill in the Metro Toronto area would probably involve a tanker truck road accident, railroad tanker car upset or a leak at an industrial tank storage facility.

Town of Vaughan Response

Mobile truck wash, transportation corridor accident.

Region of York Response

- Frequency of small reported or small unreported spills, since most of a major spill would be contained.

Town of Richmond Hill Response

Small, unreported spills from fixed installation (Households).

QUESTION 6: RE RESPONSE SYSTEM, PRIORITY OF SPILLS PROGRAM, RELATIVE TO WEIGHT TO ENVIRONMENTAL CONCERNS.

What is your response system? Is protecting the receiving water a high or low priority within your spills program? What is the relative weight given to human safety in comparison to environmental concerns?

Scarborough Response

- Response system given in a contingency plan document.

- Spill = high priority.

- Relative weight: public and staff safety is first concern, sewer and environmental concern is second.

City of Toronto Response

Inspectors are on 24 hour call. Generally, the City of Toronto's procedure is to ensure spill is contained on site and prevented from entering the sewer system. However, if the Fire Department believes there is a threat to public safety, they may flush the spill material. Once the spill enters the system, it is either cleaned up from within the system or at the outfall.

City of East York Response

No reply.

Metropolitan Toronto Response

Our response system includes the following:

- 24-hour radio dispatch centre.
- Two 2-man Industrial Waste Control response teams with pager and radio equipped vehicles covering the hours from 08:30 to 22:30 hours. Overnight calls from 22:30 to 08:30 hours are dispatched to watermain inspection crews who will make initial response and notify the dispatcher whether situation would require further attention by our Industrial Waste Control personnel.
- Our Industrial Waste Control crews' priority of actions are containment of spill, notifying local municipality and MOE if required, and locating the origin of spill. This team makes an initial judgement to determine if cleanup crews are necessary and collects evidence for possible prosecution action. Discharger is given the option of cleanup or accepting responsibility of cleanup costs.
- A Duty Officer is on call 24 hours a day.

- A District Enforcement Officer documents the incident and initiates any follow-up measures necessary to prevent a recurrence.

Town of Vaughan Response

- 24 hour dispatcher service at Public Works Department. Radio equipped service vehicles, with spill control equipment and a spill control trailer.
- Fire Department if required.
- Notify York Region and MOE in case of intermediate or major spill.

Region of York Response

- High priority for spills control.
- Priority
  - Human life first
  - Property protection second
  - Environmental protection third
- Response system
  - 25% of spills involve a direct call to Region and they respond.
  - remainder of spills involve them being called by Fire Department or local municipalities.
  - Region of York addresses immediate problem until cleaned up; depends upon SAC (MOE) to provide followup for statistics etc.
  - Region does this basically on their own initiative, as they have not received any directives or pro active liaison with MOE/SAC on the needs of a comprehensive program.

Town of Richmond Hill Response

Prime weight to human safety; secondary to environment.

QUESTION 7: WHAT IS YOUR INVOLVEMENTS IN CLEAN-UP PROCEDURES? WHAT RESOURCES ARE AVAILABLE? ARE STAND-BY CREWS USED?

Scarborough Response

Answers given in their contingency plan document.

City of Toronto Response

Available equipment is minimal, since the City's involvement in clean-up only occurs when the spill has entered the sewer system, or receiving waters. Recently booms have been purchased to contain spill plume to area of the outfall. Pumps and vactor trucks available to remove material from the sewer is possible. Sand readily available to be spread on surface spills.

Metropolitan Toronto Response

If a discharger is unable or refuses to take clean-up measures, the local municipality's Public Works Department and Metro Toronto Works Department will carry out the clean-up operations.

Metro Toronto Works Department has two spill control trailers, one located in the east end and one in the west end of Toronto. The trailers are equipped with booms, absorbent materials, pumps, collapsible holding tanks an night lights with electric generators.

Cost of clean-up may be billed to discharger and/or prosecution charges laid. Where responsibility cannot be established, clean-up costs will be borne by the local municipality and Metropolitan Toronto Corporation.

Town of Vaughan Response

Vaughan supplies men and material for the containment, clean-up, disposal and restoration within the road allowance and assists property owners within private properties. In case of serious or emergency cases, Vaughan performs work within private properties.

Region of York Response

- Attempt to assist spills provocateur or to clean up themselves.
- One section in Works Department is trained in environmental spills.
- Other resources (roads, water crews) are pulled in to assist, if priority situation.
- Equipment includes booms, pads, etc.

Town of Richmond Hill Response

We utilize our own crews, Works Department Employees, Regional Employees, the Fire Department, and MOE.

QUESTION 8: WHAT TYPE OF MANAGEMENT PROGRAMS AND/OR MODIFICATIONS TO EXISTING PROGRAMS ARE NEEDED TO MANAGE SPILLS?

Note: Answers are composited for this question.

- To manage spills, adequate training programs are required for clean-up crews to maintain cohesive action. Personnel used for clean-up operations should be able to leave their normal work duties on short notice.
- A more comprehensive Spills Contingency Plan.
- The Fire Department needs to develop an Emergency Contingency Program, which includes spill containment.

- For the present requirements of response to a problem (i.e., controlling spills), there is an excellent record of response and coordination among major agencies involved.

- More follow-up from SAC (of MOE) and direction for improving planning for future spills is required.

- Each municipal professional dreads the occurrence of a large event for which contingency planning is either too limited or potentially ineffective. Such events include spills resulting from:

  - clouds from industrial accident/fire.
  - an equivalent event to Mississauga Train Wreck.
  - large chemical spill.

- This is part of our normal fire and works department operations.

QUESTION 9: **WHAT TYPES OF CONTROL OPTIONS ARE CURRENTLY USED TO PREVENT OR MINIMIZE SPILLS REACHING WATER COURSES? WHAT CONTROL OPTIONS ARE USED TO MITIGATE THE IMPACT UPON RECEIVING WATERS?**

Scarborough Response

Answer available in "Contingency Plan".

City of Toronto Response

The main objective in dealing with spills is the containment of the spill on-site and to prevent it from entering the sewer system. This is done by dykeing or blocking the access to the sewers. If the spill has entered the sewers, booms that were recently purchased will be laid around the outfall to contain the spill. The spill is then cleaned up at the outfall and/or from within the sewer system.

East York Response

No reply.

Metropolitan Toronto

Control options generally used at industrial sites are in the form of dykes, interceptors, sluice gates, catch basin and audible alarm systems.

Town of Vaughan Response

Absorbents, dykes, pumping fluids, excavate solids.

Region of York

- Of 68 spills, approximately 10 may have been flushed.
- Rest were handled by dyking and absorbents and subsequent pickup to landfill or redirected to sewer system.

Town of Richmond Hill Response

The usual absorbent collecting equipment.

QUESTION 10: WHAT NEW OR ALTERNATIVE TYPES OF CONTROL OPTIONS ARE REQUIRED TO CONTROL/MITIGATE SPILLS?

Note: Responses are compiled herein.

- Best Management Practices Plan (BMP).
- Adopt Best Management Techniques Economically Achievable.
- Structural abatement techniques on industrial plazas along water courses are a priority.

- o Wet ponds on ditches along transportation corridors (401, 400, etc.).

- o Enhanced mandate of spills response agencies.

QUESTION 11: DO YOU HAVE ANY ESTIMATED COSTS FOR THE FOLLOWING?

a) costs of your present spill management system?
b) cost of an optimum management system?
c) costs of control options, either presently used or desirable for future usage?

Scarborough Response

a) Fire Department costs = ?
Works Department costs = 10,000 (Ops. & Maint.), 30,000 (staff). Most costs are recovered by Work Orders accessed against spiller.

b) Whatever cost of MISA level requirements (approximately $8.00 per capita).

c)
- Improve "containment equipment".
- Dedicated "spills trailer" plus primary/secondary crews.
- Development plans to include wet/dry ponds in industrial areas. These multi-stage ponds may have special extraction devices. Creation costs = capital; operation costs = MOE subsidized?; spill cost = assessed against spiller.

City of Toronto Response

No estimates.

City of North York Response

No estimates.

Metropolitan Toronto Response

Cost of our present spill management system:

Wages	$	130,000 yearly
Vehicles	$	30,000 (replicated every four years)
Booms	$	4,000
Trailers	$	24,700

Town of Vaughan Response

a) $25-30,000/annum
b) $75-100,000/annum
c) $50-75,000/annum

Region of York Response

- Line item for spills - $5,000 for supplies for spills containment (absorbent material, replacement for coveralls.

- Extra costs from general budget ($30,000/year for workers time).

- Fire department costs - $3,000-5,000 per spill (estimate).

Town of Richmond Hill Response

Present system costs include:

- $10,000 budgetted for 1989 for recovery drums, flooding dams, etc.

- Works Department and Fire Department each spend about $1,000 annually for present spills management system.

QUESTION 12: **IF YOU HAVE A SIGNIFICANT RURAL/AGRICULTURAL SECTOR WITHIN YOUR JURISDICTION, COULD YOU PLEASE ATTEMPT TO ANSWER THE ABOVE 11 QUESTIONS FOR THE RURAL SECTOR SEPARATELY.**

Scarborough Response

In 10 year history we have had no known spills in the rural area.

Town of Vaughan Response

Included in questions above.

Metropolitan Toronto Response

No spills have been attended in rural areas.

Region of York Response

- Rural areas included in answers above. Most of attention is given to transportation related spills.
- Some spillage of agricultural chemicals may occur, but no response data are available.
- Such rural-based spillage may be due more to mismanagement than to being an accidental spill.
- Such rural-based spills due to mismanagement (or intentional spills) also occur in urban areas, probably at a higher rate due to the larger density of people.

Town of Richmond Hill Response

Our active farming has been reduced naturally in the past 10 years and will be down to zero by 2000 A.D. We are not aware of agricultural problems.

APPENDIX 3

CRITIQUE OF SPILLS RESPONSE DEVELOPED FROM FEBRUARY 1989 RAP SURVEY

APPENDIX 3: Critique of Spills Response Program Developed From February 1989 RAP Survey

A survey of various municipal programs was undertaken to develop information for the Remedial Action Plan for Toronto (Anderson, 1989). This appendix presents a critique of their funding with respect to the municipal spills response and management program in all jurisdiction affecting the Toronto waterfront. Their study results were developed for:

- o Region of Peel and contained municipalities;
- o Metropolitan Toronto and contained municipalities;
- o Region of York and contained municipalities; and
- o Region of Durham and Town of Pickering.

Pertinent results are summarized herein for the following aspects:

i) the breadth of their survey;

ii) the relative importance attached to spills as demonstrated by present budgets and potential budgets required for the RAP.

A3.1 Description of Nature of Spills Programs in Different Municipalities

Durham Region

No formal program.

Metro

- o All local municipalities equipped to respond to spills.
- o Etobicoke and Scarborough identified specific response and control program.
- o Others - respond only in emergencies.
- o Produce documents used in Metro, Etobicoke, Toronto, North York, Scarborough.
- o First response - fire department and works department.
  - Metro and MOE uniformed, depending upon magnitude of spill.

o Expenditures
  - see total.
  - Metro $130,000
  - Local $28,000 - $50,000
  - Costs of clean-up may be recovered, where person responsible can be identified.
  - Of Etobicoke 1989 budget of $189,000 they expect to recover $99,000.

o More spills are being reported each year due to larger number of occurrences and greater public awareness.

o Prime responsibility for clean-up (organization causing spill, local municipality, Metro, MOE) is not clear inall cases.

o Potential for improvement.

a) communication during first contact.
  . accuracy, type of information required to identify spill.
  . anology to fire department/ambulance/police respond.

b) data base on industrial establishments, their processes and nature of their materials.

c) potential depletion of effort.

Etobicoke Detailed Records Example

	1987	1988
Small spills	100	162
Large spills	27	39
Petroleum related	72	133
Chemical related	55	68

Scarborough

- o 3 to 4 chemical pollutant spills/week.
- o 80% petroleum related.
- o 95% of spills are 5 gal or less.

Overall, 1988

- o 450 small spills recorded in all Metro in 1988.
- o 61 large spills.
- o All recorded spills were acted upon.

Region of York

- o Both region and municipalities have spill response and control program.

- o Region - Technical support section of Eng. Dept.
  - Local - Works Dept./Fire Dept.

- o Total program cost - $10,000/yr.
  - High priority
  - Operate on 24 hour per day emergency basis.

- o Spills - Small, increasing in number.
  - Regard York suggested that: 1) increased land use and traffic patterns contribute to this increasing trend.
    2) increased public awareness.

- o Data (1988) - 20-30 small spills acted upon by local municipalities.
  - 52 small spills acted upon by region.
  - 1-5 large spills acted upon by each local municipality.
  - 12 large spills in Region of York.

- Region of York's Priorities
  - Provincial spill response network capable of physical rather than directional assistance.
  - Town of Richmond Hill - undetected or unreported spills, especially from household domain.

Peel

- Responsibility of Public Works - program in existance for 14 years.
- $200,000 in 1988, one full time; 3 part time.
- 1988 - 74 small spills; 20 large spills.
- New reporting methods.
- Optimum program - fully equipped, specialized response vehicles.
  - one full time coordinator; 2 assigned permanent staff.
  - fire department has own response vehicle.
- Responsibility/liability for unknown spills (i.e. unknown party responsible).
- Roles (works/fire) now will defend in light of additional capabilities of fire dept. and new requests of spills bills.

A3.2 Points Made in Discussion

		Total Budget	Local	Region
1.	Total Budget	York $43/1000 people	RIF $200/1000 Whitechurch $213/1000	$6/1000
		Metro $93/1000 people	N. York $90/1000 Scarboro $60/1000	
		Peel $333/1000 people		$334/1000

2. Unit Costs - York $31/spill
   - Peel #2100/spill

3. Spills Frequency 0.03 East York spills/1000 people
   1.4 Whitechurch

4. Costs - staff 87-92% in Metro
41% in Peel

5. Nature of Program - emergency nature
   - Most developed - Etobicoke, Scarborough, Peel
   - Support - Metro, Peel

6. No information on control.

7. Program Impedements

   - Whose responsibility is clean-up?
   - Accurate and adequate information is not presently received.
   - Storm sewer maps are not up to date.
   - Geogrpahical size of response team.

8. Optimum program
   - difficult to see due to unpredictability of occurrence.
   - not economical to maintain staff by crews.
   - improve programs.

A3.3 Conclusion Developed for Spills Response and Control Program

- Response Level - five.

- Spills occurrence - impredictable
  Likelihood - depends on:
  - number of industries
  - transportation
  - traffic
  - population

- 95% of spills are small (LT 100 L) relating to small vehicle accidents and other incidents, not involving industry.

- Average = 0.35 spills/1,000 people; range of 0.3 (East York) to 1.4 (Whitechurch).

- Programs - involve cooperation of Fire Department.
  - Response a) Experienced personnel - "Responds"
    b) Available personnel - whoever is available.

- Program effectiveness - questionnaire did not quiery well; little information is available.

- Program Improvements and Costs

  a) Highest level
  - emergency outfit on standby, fully equipped and staffed.
  - not economical.
  - none if municipalities have intention to proceed this way.
  - Since fire departments are involved, use of emergency staff would be uneconomical and partly redundant.

  b) Cost projection based upon 0.5 spills/1,000 people/year.
  Average cost of $262/spill to $300/spill for local and regional municipalities.

  Metro Costs - $130,000 for 1988 for 589 spills - average cost to region of $220.

  Regional costs (local and regional municipalities)

Durham	$ 90,000
Metro	601,000
Peel	162,000
York	96,000

Suggestions for improving spills control program.

- designated members of Works Department staff should be instructed in correct procedures and techniques for dealing with spills.

- Spills centers should be established (perhaps near fire departments) to allow even access times to most areas - how about designating key reception.

- Properly equipped vehicles should be available at spills centres; equipment should be sufficient to deal with most major spills.

- In addition to industrial data bases being developed, a spills report should be filed with Spills Action Centre.
  - nature of spill
  - procedures used
  - some measure of effectiveness of the region

- Initially - one spills centre/municipality together with equipped vehicles.
  Costs
  - vehicles,
  - establishment of centre,
  - training of staff, and
  - purchase of computer equipment to access the database.

- R.V. Anderson - spills response procedures in municipality should be reviewed and evaluated in greaterdepth before proposing funding charges to program.

FIGURE 1: QUESTIONS RAISED

Definition of Spill: An accidental or purposeful release of a pollutant to urban areas in a pulse manner which will reach rivers/lakes through ditches or stormsewer systems.

Program Administration

1. (a) What is the municipal name of the spill response and control program.

   (b) To what department does this spill response and control program belong.

2. (a) How are the spill response and control programs funded in 1988?

   i) Total Program Cost $
   ii) Source of Funding: . Organization (1) $
   . Organization (2) $
   iii) Value of Complement of Staff $

   (b) Will the funding for the spill response and control program be different in 1989? (Yes or no).

3. What resources are allocated to the spill response and control program in 1988 and 1989?

   Capital $
   Operating and Maintenance $
   Staff $
   No. of Person Years

4. What is the ranking of the municipal spill response and control program in municipal priorities in1988 and 1989? (High, Medium, Low)

Program Operation and Effectiveness (Excluding Spills to Sanitary Sewers)

5. What is the trend in the number of spills identified for the 5 year period. 1984-1988 inclusive for small spills (LT 100 L) and large spills (GT 100 L)? No change, decreasing, or increasing?

6. How effective is the spill response and control program for:

   i) small spills identified in 1988.
   ii) small spills acted upon in 1988.
   iii) large spills identified in 1988.
   iv) large spills acted upon in 1988.
   v) number of spills classified as toxic in 1988.

7. Are you implementing improvements to the spill reporting response and control program, effective in early 1989?

8. How do you view the progress of your spill response and control program? (Good. Fair, or Poor?)

9. (a) Other than resource limitations, what, if any, impedements do you encounter to implementation of an effective spill response and control program?

   (b) What additional resources (number of staff; costs for disbursements and support) are necessary to overcome the key impedements identified above?

10. Do you have a spill response procedures document.

11. Do you anticipate any substantial change in your spill response and control program in the next 10 years?

12. What do you feel would constitute an optimum spills response and control program?

TABLE 1: 1988 BUDGETS FOR CURRENT REMEDIAL PROGRAMS FOR REGIONAL MUNICIPALITIES AND THEIR LOCAL MUNICIPALITIES WITHIN DON RIVER WATERSHED

Region	Cross Connection	Spills Program	Infrastruct. Program	Infrastruct. O & M	Infrastruct. Studies	Bylaws Pet Control	Bylaws PlumbING Inspection	Bylaws Sewer Use	Catch-basin Cleaning	Hazard-ous Waste	Aesthetic Clean-Up
Metro											
City of York	40,000	-	1.58 mill	1 mill	90,000	9,000	-	-	52,000	0	0
East York	0	1,000	4.3 mill	1.3 mill	-	85,000	35,000	1,000	59,000	0	-
Etobicoke	58,000	-	1.2 mill	1.68 mill	-	505,000	333,000	-	75,000	0	-
North York	66,000	50,000	-	8.5 mill	150,000	671,000	-	700,000	260,000	0	-
Scarboro	107,000	28,400	5.9 mill	5.25 mill	622,000	-	-	107,000	86,800	0	160,000
Toronto	22,000	-*	7.59 mill	9.37 mill	-	0	-	-	403,000	0	31,900
Metro	75,500	130,000	-	4.16 mill	395,000	-	0	863,000	-	200,000	0
York											
Markham	-	-	-	-	-	-	-	-	-	0	-
Richmond Hill	-	10,000	3 mill.	326,000	27,000	83,100	-	0	11,100	0	78,000
Whitechurch	-	3,000	-	-	-	-	-	0	0	0	-
York	-	2,000	-	-	-	0	0	60,000	59,000	-	0

* No value available since it is a part of the normal operating budget.

TABLE 2: NORMALIZED EXPENDITURE FOR CURRENT REMEDIAL PROGRAMS ($/1,000 PEOPLE)

Region	Cross Connection	Spills Program	Infrastruct. Program	Infrastruct. O & M	Infrastruct. Studies	Bylaws Pet Control	Bylaws Plumbers Inspection	Bylaws Sewer Use	Catch-basin Cleaning	Hazard-ous Waste	Aesthetic Clean-Up
Metro											
City of York	296	-	11,700	7,400	667	67	-	-	385	0	0
East York	0	10	42,600	13,100	-	842	347	10	584	0	-
Etobicoke	192	-	3,900	5,500	-	1,670	1,102	-	248	0	-
North York	119	90	-	15,300	271	1,210	-	1,260	469	0	-
Scarboro	221	59	12,200	10,900	1,290		-	221	180	0	3,300
Toronto	36	-	12,500	15,400	-		-	-	663	0	52
Metro	35	60	-	1,900	181		0	395	-	92	0
York					-						
Markham	-	-	-	-	-	-	-	-	-	0	-
Richmond Hill	-	213	64,000	6,900	574	1,770	-	0	236	0	1,660
Whitechurch	-	200	-	-	-	-	-	0	0	0	-
York	-	6	-	-	-	0	0			-	0

TABLE 3: SPILLS RESPONSE AND CONTROL

			Reported Spills									
		1988	1988 Reported Spills			Unit Cost	Spills Per	% Small	% Large	Priority	Priority	1989
Region	Municipality	Funding	Small	Large	Total	Per Spill	1,000 People	Spills	Spills	1988	1989	Budget
Durham	Pickering									NR	NR	0
	Durham		3	3	6			50	50	Low	Low	0
Metro	City of York									High	High	
	East York	1,000	3		3	333	.03	100	0	Low	Low	
	Etobicoke		162	39	201			81	19	High	High	72,000
	North York	50,000	100	5	105	476	.67	95	5	High	High	0
	Scarborough	28,400	150	9	159	179	.19	94	6	Medium	Medium	31,700
	Toronto		35	7	42	-	.33	83	17	High	High	0
	Metro	130,000					.07			High	High	0
Peel	Brampton									NR	NR	0
	Caledon									NR	NR	0
	Mississauga									NR	NR	0
	Peel	196,770	74	20	94	2,090	.16	79	21	Medium	Medium	133,000
York	Markham									NR	NR	0
	Richmond Hill	10,000	35	5	40	250	.85	88	13	High	High	0
	Whitechurch	3,000	20	1	21	140	1.40	95	5	NR	High	0
	York	2,000	52	12	64	31	.18	81	19	High	High	2,000

TABLE 4: BIOPHYSICAL DATA AND CATCH BASIN CLEANING COSTS

	1985 Population	Area (ha)	(1986) Persons Per Household	1988 Population Density (people/ha)	No. of CB	Estimated Cleaning O&M Costs @ $20	Disposal @ $18
Durham							
Pickering	45,700	22,138	2.9	2.0	2,600	52,000	47,000
Durham Region	315,000	242,184	2.7	1.3	N/A		
Metro							
East York	97,000	2,159	2.2	47	4,500	90,000	81,000
Etobicoke	298,000	12,709	2.6	24	22,000	440,000	396,000
North York	556,000	17,985	2.8	31	29,500	590,000	531,000
Scarborough	461,000	18,737	2.8	26	26,000	520,000	468,000
Toronto	606,000	9,866	2.2	62	32,240	665,000	580,000
York	134,000	2,400	2.4	57	5,240	104,000	94,000
Metro	2,154,000	63,800	2.5	34	N/A	-	-
Peel							
Brampton	178,000	27,100	3.0	6.9	11,000	270,000	198,000
Caledon	29,000	70,000	3.0	0.4	900	18,000	16,000
Mississauga	360,000	29,200	2.9	13	26,000	520,000	468,000
Peel	566,000	126,000	2.9	4.7	2,475	50,000	45,000
York							
King	16,000	33,900	3.0	0.5	350	7,000	6,300
Markham	105,000	20,600	2.9	5.5	7,000	140,000	126,000
Richmond Hill	44,000	9,800	2.8	4.8	2,200	44,000	29,000
Vaughan	57,000	26,200	2.7	2.5	3,500	70,000	63,000
Whitechurch Stouffville	14,000	20,100	2.6	0.7	350	7,000	6,300
York	324,000	172,000	2.8	2.0	3,400	68,000	61,200
						3,584,000	3,226,000

TABLE 5: COSTS FOR SEWER OUTFALL MONITORING AND CROSS CONNECTION TRACING

	Sewer Outfall Monitoring ($1,000's)				Cross-Connecting Tracing		Infiltration Control	
	No. of Outfalls	Sampling	Lab	Total	No. of Stormwater Outfalls	Cross-Conn. Tracers & Required ($1,000)	Length of Sanitary Sewers (km)	Inflow/ Infiltration Removal ($1,000)
Durham								
Pickering	90	27	45	72	90	63	132	600
Durham	-	-	-	-	-	-	-	-
Metro								
East York	90	27	45	72	90	630	169	845
Etobicoke	590	83	260	343	520	3,600	890	4,450
North York	720	115	360	475	720	5,040	1,250	6,250
Scarborough	760	122	380	502	700	5,320	1,110	5,550
Toronto	400	72	200	272	400	2,800	1,186	5,930
York	120	33	60	93	120	840	253	1,265
Metro	-	-	-	-	-	-	-	-
Peel								
Brampton	320	58	160	218	320	2,240	474	2,370
Caledon	30	16	15	31	30	210	48	240
Mississauga	760	137	380	517	716	5,320	1,140	5,700
Peel Region	80	25	40	65	80	560	1,800	9,000
York								
King	20	14	10	24	20	140	18	90
Markham	200	48	100	148	200	1,400	300	1,500
Richmond Hill	70	23	35	58	70	490	148	740
Vaughan	120	33	60	93	120	840	174	870
Whitchurch - Stouffville	20	14	10	24	20	140	18	90
York Region	110	21	55	76	110	770	N/A	-
	4,430	868	2,215	3,083	4,430	31,000	9,110	45,500

TABLE 6: ESTIMATED SEWER USE CONTROL COST UNDER MISA PROGRAM

Region	1988 Population	Capital Costs x 1,000	Annual Costs x 1,000
Durham	325,000	650	975
Metro	2,183,000	4,366	6,549
Peel	590,000	1,180	1,720
York	349,000	698	1,047
	3,447,000	6,900	10,341

TABLE 7: ESTIMATED COST FOR INFRASTRUCTURE REHABILITATION AND REPLACEMENT

Municipality	Length of Sanitary (km)	Annual Replacement Costs ($million)	Length of Storm Sewer (km)	Annual Replacement Costs ($million)	Total Annual Cost ($million)
Durham					
Pickering	132	1.35	132	1.35	2.70
Durham					
Metro					
East York	169	1.72	127	1.30	3.02
Etobicoke	890	9.08	870	8.87	17.95
North York	1,250	12.75	17,250	12.75	25.50
Scarborough	1,110	11.32	1,019	10.39	21.71
Toronto	1,186	12.10	892	9.10	21.20
York	253	2.58	127	1.30	3.88
Metro	-	-	-	-	-
Peel					
Brampton	474	4.83	474	4.83	9.66
Caledon	48	0.49	48	0.49	0.98
Mississauga	1,140	11.63	1,140	11.63	23.26
Peel	-	-	-	-	-
York					
King	18	0.18	18	0.18	0.36
Markham	300	3.06	300	3.06	6.12
Richmond Hill	148	1.51	78	0.80	2.31
Vaughan	174	1.77	174	1.77	3.54
Whitechurch	18	0.18	18	0.18	0.36
York	N/A	-	-	-	-
	7,310	74.55	6,607	68.00	142.50

TABLE 8: COSTS FOR O&M OF SEWERS AND SPILLS PROGRAM

	ESTIMATED O&M (ANNUAL) & STUDY COSTS				ANNUAL COSTS OF SPILLS RESPONSE			
	Length of All Sewers (km)	Annual O&M ($1000)	SIMS Studies ($1000)	Projected Spills	Local Municipal Budget ($)	Regional Municipal Budget ($)	Total Cost Within Local Municipalities ($)	Total Expenditure Within Region ($)
Durham								
Pickering	264	1,320	264	23	6,100	5,750	12,650	
Durham Region	N/A			163	42,000	35,000*	97,000	89,650
Metro								
East York	296	1,480	296	51	15,300	12,750	25,050	
Etobicoke	1,700	8,800	1,700	151	45,300	37,750	83,050	
North York	2,500	12,500	2,500	277	83,100	69,250	152,000	
Scarborough	2,130	10,645	2,129	242	72,600	60,500	133,000	
Toronto	2,080	10,390	2,078	304	91,200	76,000	167,000	
York	380	1,900	380	68	20,400	17,000	37,000	
Metro Toronto	N/A	-	-	1,093	-	273,000*	-	601,000
Peel								
Brampton	948	4,740	948	94	28,200	23,500	51,700	
Caledon	96	480	96	15	4,500	3,800	8,300	
Mississauga	2,280	11,400	2,280	186	55,800	46,500	102,000	
Peel Region	1,800	9,000	1,800	295	-	43,800**		162,000
York								
King	36	180	36	8	2,400	2,000	4,400	
Markham	600	3,000	600	57	17,100	14,300	31,400	
Richmond Hill	226	1,130	226	24	7,200	6,000	13,200	
Vaughan	348	1,740	348	33	9,900	8,300	18,200	
Whitechurch	36	180	36	8	2,400	2,000	4,400	
York Region	N/A	-	N/A	175	13,500	11,300	24,800	96,300
	15,800	78,900	15,800			43,800*		

* Projected Municipal Budget

** Assumed to be Additional Costs to Those Expanded Within Each

TABLE 9: SUMMARY OF STORM SEWER OUTFALLS FROM PREVIOUS STUDIES

Outfall Information	NUMBER OF OUTFALLS (% OF INVENTORY)				
	Mimico Creek[1]	Don River[2]	Humber River[3]	Highland Creek[4]	Toronto Waterfront[5]
Inventory	194	1,423	624	486	
Active (flowing)	87	689	366	364	
Not Sampled	15	59	NA	NA	
Sampled Once	72	NA	239	NA	
Sampled Twice	69	NA	NA	NA	
Intensive Sampling	33 (17%)	170 (12%)	84 (13%)	65 (13%)	
Priority Outfalls					
- Group A	26 (13%)	156 (11%)	60 (10%)	75 (15%)	
- Group B	22	284	NA	NA	
Study Area (ha)	8,000	36,000	13,000	NA	
No. of ha/outfalls	41	25	21		

Information Sources

1. TAWMS Tech. Report #12 (MOE; 1987)
2. TAWMS Tech. Report #1 (MOE, 1983)
3. TAWMS Tech. Report #1 (MOE, 1989)
4. Highland Creek and Roys River. MOE WWQIP Notes, 1988.
5. Data no available. All outfalls have been tested.

NA - not available

FIGURE 2: ASSUMPTIONS

1. Table 4: CB Cleaning Costs

   a) O&M Unit Cost: $10 per CB x twice yearly cleaning = $20 per CB.

   b) Disposal Unit Cost: $60 per tonne x 100 kg per CB x twice yearly = $18 per CB

2. Table 5: Costs of Sewer Outfall Monitoring

   a) Number of catchbasins - where numbers are unavailable,
   1.4 CB/hectare for municipalities greater than 100,000.
   1.2 CB/hectare for municipalities less than 100,000

   b) Estimated number of stormwater outfalls = one outfall/25 hectares of drainage area.

   c) Sampling frequency of stormwater outfalls: one initial visit to each outfall; 40% are sampled once; 15% are sampled four times.

   d) Sampling cost = $180 to $190 per outfall.

   e) Laboratory (Analytical Cost) = $500/outfall based upon 2 samples (average) per outfall and chemical analyses for 1 CP metal scan; phenols, bacti, and "5-6 samples" tests.

3. Table 5: Costs of Cross-Connection Tracing and Removal

   a) $15,000 per cross-connection; 3 cross-connections per priority outfall; .15 priority outfall per outfall = $7,000/outfall.

   b) $5,000 per km of sewer for inflow/infiltration removal.

4. Table 6: Cost Assumptions

   - Costs are based upon MOE estimates for proposed MISA sewer use control program.

   a) Capital costs = $2.00/capita
   b) Annual operating costs - $3.00/capita

5. Table 7: Cost Assumption

   a) Replacement costs = $510,000 per km of storm or sanitary sewer for a 50 year replacement cycle.

6. Table 8: Cost Assumption for Annual O&M Sim Study Costs

   a) Annual O&M cost at $5,000/km of storm or sanitary sewer and 5% coverage by TV inspection.

   b) SIM study costs = $1,000 per kim.

7. Table 8: Spill Response Cost Assumption

   a) 0.5 spills per 1,000 people
   b) Local municipality costs = $300/spill
   c) Regional municipality costs = $250/spill

APPENDIX 4

SPILLS SUMMARY FROM TAWMS STUDY REPORT (1986)

APPENDIX 5

UPDATED SUMMARY OF SPILLS INFORMATION FOR TAWMS (DON RIVER) STUDY

SUMMARY OF SPILLS

Municipality: Metro Works - V. Lim 392-2966

Frequency: 3-6 spills per week

Action Taken: Investigates complaint calls from general public and reported spills by mainly commercial and industrial establishments. Locates origin of spills and offender is directed to conduct clean-up operations. Local municipality and/or Metro Works Dept. does the clean-up if offender refuses. Costs of clean-up may be billed to offender. Bylaw prosecution charges are laid on a case-by-case basis.

Where responsibility cannot be established, the local municipality and/or the Metropolitan Toronto Corporation does the clean-up and bears the cost.

Type of Spill/Source: Petroleum products; solvents; paints; chemicals.

Industrial properties/malls; roadways; storm catch basins.

Parameters Analysed for: Identification of material; phenols, gasoline, hydrocarbons, mineral/vegetable oils, solvents.

Notes:

1) Maintains two spill control trailers.
2) Complaints investigation crew on duty seven days per week.
3) 24-hour dispatch centre.
4) Laboratory equipment includes:
   gas chromatograph, atomic absorption, ultra-violet, infra-red, spectrophotometer, pH meters.
5) Spill statistics for municipalities having combined sewers (City of York, City of Toronto), may be underrated; spills may be diverted through the interceptor to the W.P.C.P. rather than to a watercourse, thus not detected if not reported at origin.

Municipality: Township of Vaughan - B. Nyitrac 832-8525

Frequency: 2/month

Action Taken: Our Public Works Department has responded to 22 spills, during the year of 1987. 18 minor spills were contained and cleared up by the originator and the Town of Vaughan Works Department. 4 intermediate spills were reported to MOE and cleared up by the Town of Vaughan Works and Fire Department.

Type of Spills: Fuel, oil, grease, detergent.

Parameters Analysed For: No information given.

Notes:
1) Equipment Maintained
2) Radio-equipment service vehicles with spill control equipment and a spill control trailer.